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The U.S. Sunflower Industry

Ian McCormick
Cecil W. Davison
Roger L. Hoskin

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Abstract

U.S. sunflowerseed production increased tenfold during the 1970's and approached 6 million acres, but declined to less than 2 million acres by the late 1980's, ranking 17th in value among U.S. field crops. Output rose in response to growing demand for sunflowerseed oil and declined because of increased competition abroad and increasingly attractive returns from competing crops and land uses at home. Recent changes in domestic agricultural policies, combined with increased marketing opportunities both at home and abroad, have led to renewed interest in sunflowers among producers, processors, and input industries. Also, the relatively low level of saturated fat in sunflowerseed oil and its other technical characteristics have increased the oil's popularity among consumers. This report describes the U.S. sunflower industry from producers to consumers and provides a single source of economic and statistical information on sunflowers.

Keywords: Sunflowers, sunflowerseed oil, sunflowerseed meal, oilseeds, production, demand, Government programs, prices, marketing, exports

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Highlights

The cultivated sunflower typically ranks among the world's top five oilseed crops, comprising about 10 percent of world oilseed output over the last 5 years. Sunflowerseed oil, the principal product of sunflowerseed processing, comprised nearly 14 percent of world vegetable oil production and 12 percent of world vegetable oil trade between 1987 and 1991. U.S. sunflower production is primarily concentrated in the Plains States, with North Dakota, South Dakota, Minnesota, Kansas, Nebraska, and Texas producing 95 percent of U.S. output in 1991.

U.S. sunflower output increased tenfold during the 1970's, peaking at 7.3 billion pounds in 1979, but declined to a third of that level by 1990. The United States, currently ranked fifth in world production, increased output in the late 1970's in response to growing demand for sunflowerseed oil. Production declined during the 1980's, partly because many farmers participating in Federal farm programs chose to plant subsidized program crops rather than nonsubsidized crops such as sunflowers. Interest and production have since risen, partly due to new domestic farm policies that increase the attractiveness of producing sunflowers in the United States.

Sunflower production is of two types: oil and confections. Oil-type sunflowerseeds are processed to produce sunflowerseed oil and meal. The oil is used in food manufacturing, as a frying oil, and in margarine and spreads. Sunflowerseed oil is relatively low in saturated fats, which has increased its popularity among health-conscious consumers. The meal is primarily used as a high-protein livestock feed ingredient. Confection sunflowerseeds are used as a snack food and in baked goods. Both oil-type and confection sunflowerseeds are used in bird-food mixes.

The higher valued oil accounts for around 80 percent of the seed value. U.S. sunflowerseed-oil prices tend to move with other edible oil prices. Confection sunflowerseed typically commands a higher price for the producer than oil-type seed, partly reflecting higher production costs.

Sunflowerseed trade constitutes about 5 percent of world oilseed trade, behind soybean and rapeseed, 75 and 11 percent, respectively. Argentina and the European Community (EC) are the major exporters of sunflowerseed, sunflowerseed meal, and oil (including intra-EC trade). The EC buys around 80 percent of the world's sunflowerseed and sunflowerseed meal exports (including intra-EC trade) and is a net importer of these commodities. The EC is also the leading importer of sunflowerseed oil, taking 23 percent of world imports in 1987-90. The U.S. share of the world sunflowerseed oil export market has grown to nearly 11 percent.

Most U.S. sunflower production throughout the late 1970's and early 1980's was exported. As sunflower and other oilseed production increased in Europe and Argentina, U.S. exports fell, and a larger portion of the crop was used domestically. Oil exports have replaced seed exports as the primary outlet for U.S. sunflowerseed. Oil exports (seed equivalent basis) account for roughly 80 percent of exports. Moreover, the remaining seed exports are primarily used for confection, in contrast to the late 1970's and early 1980's when seed was primarily exported for oil and meal production.

This report describes the U.S. sunflowerseed industry from producers to consumers and provides a source of economic and statistical information on sunflowers.

The U.S. Sunflower Industry

Ian McCormick, Cecil W. Davison, and Roger L. Hoskin*

Introduction

The cultivated sunflower *Helianthus annuus* L. typically ranks among the top five oilseeds in world production, comprising about 10 percent of world oilseed output over the last 5 years. Although dwarfed by soybeans, its major competitor, sunflowerseed remains an important source of oil and meal in many areas of the world, notably the former Soviet Union and Eastern Europe. Sunflowerseed oil, the principal product of sunflowerseed processing, comprised nearly 14 percent of world vegetable oil output and 12 percent of world trade between 1987 and 1991.

Although sunflowers are native to North America, commercial sunflower production is relatively new to U.S. agriculture and has yet to gain acceptance as a major crop. Sunflowers ranked 15th among the top 30 U.S. field crops in value in 1991, yet accounted for only 2 percent of U.S. oilseed production. Production is primarily concentrated in the Plains States, with North Dakota, South Dakota, Minnesota, Kansas, Nebraska, and Texas contributing 95 percent of national production in 1991. In these States, sunflower production and processing represent an important component of the local economy, where production alone added an estimated $292 million to farm incomes in 1991 (table 1). Sunflower acreage has recently expanded in Colorado and Nebraska, initially for the confection and bird-food markets.

U.S. sunflower production has been erratic. Planted acreage that approached 6 million acres in the late 1970's fell precipitously throughout much of the 1980's before rebounding from 1989 to 1991. In the past, the health of the industry was tied almost exclusively to exports. In recent years, domestic demand for sunflowerseed and its products has become increasingly important. Recent changes in Federal farm policy, and growing domestic and international markets for sunflower products, make sunflowers more attractive to U.S. producers.

This report provides information on the structure and performance of the sunflower industry and examines trends in production, demand, and prices. Cost of production, marketing strategies, processing, policy, and international trade are also discussed.

Table 1--Sunflowerseed value of production, 1991

State	Principal crops	Sunflowers	Percent of total value
	---Million dollars---		
North Dakota	2,196	186.9	8.5
Minnesota	4,052	45.9	1.1
South Dakota	1,596	42.3	2.7
Kansas	2,529	9.4	.4
Colorado	1,138	5.6	.4
Nebraska	3,724	4.0	.1
Texas	3,945	3.5	.1
Other	60,678	7.3	--
U.S. total	79,858	304.9	.4

-- = less than 0.05.
Source: U.S. Department of Agriculture, National Agricultural Statistics Service. *Crop Values*. Jan. 1992, p. 24.

History and Origin

Of all the oilseed plants, only the sunflower can claim North America as its original home (Simpson and Ogorzaly, 1986). Archeological evidence documents sunflower use among many tribes of American Indians, with the first cultivation in Arizona and New Mexico around 3,000 B.C. (Carter, 1987). American Indians used sunflowerseed as a foodstuff before the cultivation of corn. Sunflower was also used as a medicinal crop, as a source of dye, as oil for ceremonial body painting and pottery, and as a hunting calendar, "When sunflower was tall and in bloom, the buffalo were fat and the meat good" (McMullen, 1985).

Spanish explorers collected sunflower in North America, and by 1580 it was a common garden flower in Spain. Early English and French explorers, finding sunflower in common use by American Indians, also introduced it to their respective lands. It spread along the trade routes to Southern Europe, Egypt, Afghanistan, India, China, and

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Russia. Russians began to cultivate sunflowers in the late nineteenth century. Like their Native American predecessors, the Russians selected large-headed, large-seeded sunflowers and now have varieties that can produce up to 1,000 seeds per head. Throughout the 20th century, the former Soviet Union has dominated world sunflowerseed production (McMullen, 1985; Simpson and Ogorzaly, 1986).

Small acreages of sunflower have been grown in the U.S. Northern Plains (North Dakota, South Dakota, Nebraska, and Kansas) since 1900. But the great expansion of acreage in North Dakota, South Dakota, and Minnesota did not take place until the early 1970's. The rapid expansion of world oilseed demand together with the introduction of the Peredovik variety from the former USSR in the 1960's fueled this dramatic increase in sunflower acreage. The excellent yield and high oil content of Peredovik seeds attracted companies that extracted and sold edible vegetable or industrial oils from crop plants. Higher yielding hybrid sunflowers have replaced the open-pollinated varieties, such as Peredovik, and have further improved the marketing of sunflower products (Carter, 1987).

The sunflower has one of the shortest growing seasons of the world's major oilseed crops. This means it can be successfully grown over a wider range of latitudes than many other oilseed crops. The sunflower flourishes farther north than corn and the soybean. In southern regions with growing seasons longer than 200 days, sunflower can be grown in a double-crop rotation (Carter, 1987).

The sunflower does relatively well under adverse weather conditions. The sunflower's deep root system allows for efficient use of soil moisture, and seedlings are more frost resistant than those of most other crops. Frost-resistance is important to growers in higher latitudes, where frost may strike while plants are in the seedling stage (Carter, 1987).

Types of Sunflowers

The cultivated sunflower *Helianthus annuus* L. is one of the 67 species in the genus *Helianthus*. All cultivated sunflower species are native to the Americas, and most are found in the United States. Wild, weedy populations of the species still occur throughout Canada, the United States, and Mexico, usually in pastures or disturbed areas. Wild plants are branched and bear numerous, relatively small heads. The majority of the species are perennial with only about a dozen annual species. Jerusalem artichoke (*H. tuberosus* L.) is another species grown for food and livestock feed in the United States (McMullen, 1985; Simpson and Ogorzaly, 1986).

Domesticated sunflowers usually have a single stem topped by a multiflowered head ranging from 6 to 75 centimeters in diameter. These large disk-shaped heads can support 700 to 8,000 pale-brown to black disk flowers surrounded by an outer circle of golden-yellow ray flowers. Only disk flowers can produce seed; however, many of these fail to produce seed because of genetics, weather, and other factors that affect pollination. Commercial varieties range in height from 50 to over 500 centimeters. The large upright stem and large head are supported by an extensive root system led by a taproot that can reach 4 to 5 meters, typically ranging from 75 to 125 centimeters (Knowles, 1978).

Plant breeders have made interspecie crosses within the genus and have transferred to the commercial sunflower such other useful characteristics as higher oil percentage, cytoplasmic male sterility for use in production of hybrids, and disease and insect resistance (McMullen, 1985).

Sunflower varieties are typically separated into two types: oil and non-oil. Oil-type sunflowers are primarily selected for specific oil and meal characteristics such as oil yield, oil composition, and meal protein content (the residue left after extraction of the oil). The seeds, or achenes, are black, with thin hulls that adhere to the kernels. Seeds contain 38-50 percent oil and about 20 percent crude protein by weight (Carter, 1987).

Oil-type seed is primarily grown for the crush industry to jointly produce sunflowerseed oil and meal. Growing interest in oil-type sunflowers as an ingredient in bird-food mixes has fueled additional demand for these varieties.

Confection sunflowerseeds (the principal non-oil varieties) are relatively thick and large, with striped hulls that are only loosely attached to the kernels. Domestic and export demand for confection sunflowerseed is increasing. Some of the seed is roasted, much like peanuts, while some is dehulled and the kernels sold as confectionery "nuts." Smaller confection seeds, plus new varieties developed specifically for the bird-food market, are used with oil-type seeds as food for wild birds, pet birds, and small animals.

U.S. Production

Many factors influence production, ranging from climate and soils that affect yields and input choices to technological developments and market forces that influence initial planting and management decisions. Variations in these factors through time have affected U.S. sunflower production patterns. This section discusses the various components of production, how they have changed through time, and some of the characteristics of the farms producing sunflowers in the United States.

Sunflower Acreage

Sunflowers are a relatively new arrival to U.S. commercial agriculture and do not command a large share of national

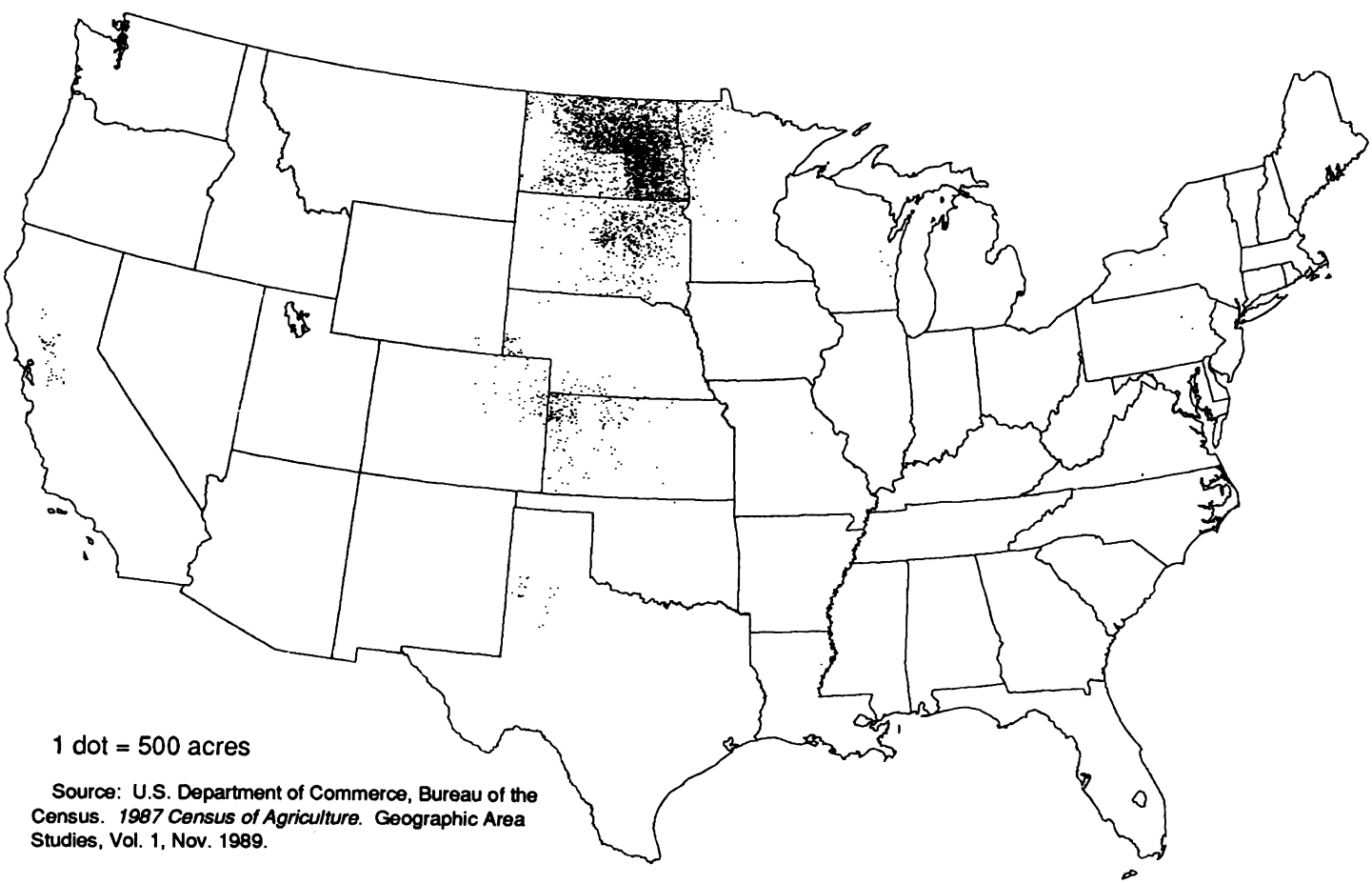
cropland. Sunflower production is geographically concentrated and is important to the local economies in such areas (fig. 1). The 1987 Census of Agriculture indicated that 95 percent of sunflower production was concentrated in four States: North Dakota, South Dakota, Kansas, and Minnesota (U.S. Dept. of Commerce, 1989). In North Dakota, the largest sunflower-producing State, sunflowers ranked third among all crops in terms of value of sales during 1987 to 1991, accounting for 8.5 percent of the cash receipts from crop production in 1991 (table 1). Nebraska, Colorado, and California also maintain significant sunflower acreage, having increased since the last comprehensive survey in 1982 (fig. 2).

Sunflower acreage has varied considerably, even in the major production areas. Prior to the oilseed boom of the early 1970's, total acreage was small, with annual planted acreage remaining below 80,000 acres through the mid-1960's (table 2). With the introduction of high-oil-yielding Soviet cultivars in the late 1960's and the development of U.S. crushing capacity, sunflower acreage increased to over 200,000 acres by 1970.

Acreage continued to rise throughout the 1970's, fueled by strong prices, improved yields, and greater seed consistency brought on by the introduction of hybrid seed varieties. Sunflower acreage had expanded to over 800,000 acres by 1976, peaking in 1979 at 5.5 million acres. The rapid rise in acreage between 1977 and 1979 reflected several developments:

- Favorable sunflower prices were maintained by increasing world demand for oilseeds and oilseed products, with Europe and Mexico providing a ready market for sunflowerseed exports.
- Wheat and barley prices declined in the face of increasing stocks, making sunflowers an attractive alternative.
- Genetic advances and improved management techniques increased potential yields, increasing the profitability of growing sunflowers.

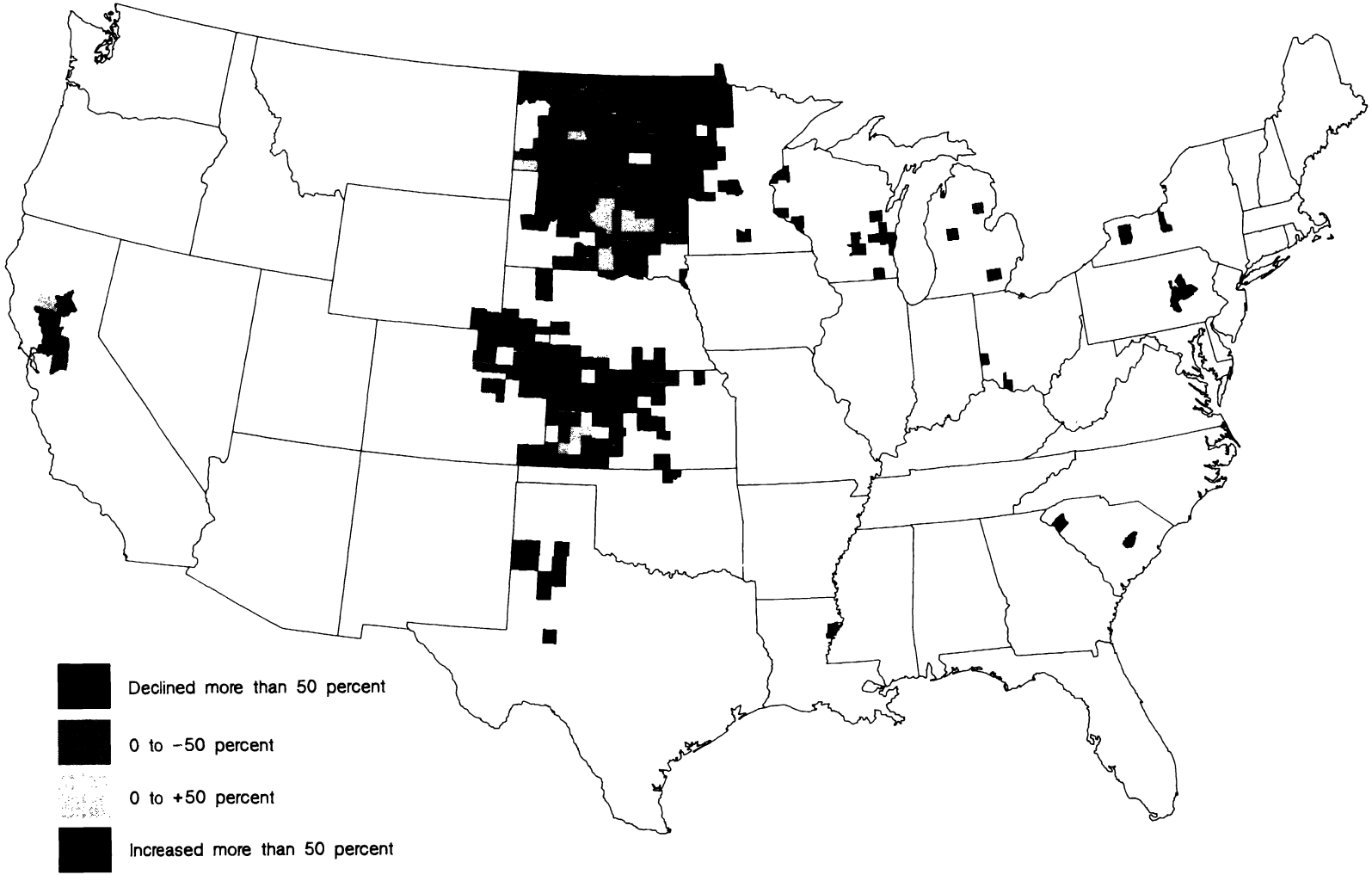
Figure 1
Distribution of U.S. sunflower harvested acreage, 1987



Source: U.S. Department of Commerce, Bureau of the Census. *1987 Census of Agriculture.* Geographic Area Studies, Vol. 1, Nov. 1989.

Figure 2

Change in U.S. sunflower harvested acreage, 1982-87



Source: U.S. Department of Commerce, Bureau of the Census. *1987 Census of Agriculture*. Geographic Area Studies, Vol. 1, Nov. 1989.

Table 2--Sunflowerseed acreage planted, harvested, yield, and production, 1962-91

Year	Planted	Harvested	Yield	Production
	---1,000 acres---		*Lbs/acre*	*1,000 lbs*
1962	13	13	980	12,250
1963	31	30	970	29,100
1964	42	40	644	25,760
1965	50	46	827	38,050
1966	76	73	894	65,240
1967	221	216	1,037	233,960
1968	156	151	1,031	155,670
1969	195	185	927	171,430
1970	219	207	902	186,670
1971	405	392	1,050	411,680
1972	719	692	916	633,560
1973	678	666	1,080	719,070
1974	572	548	957	524,750
1975	787	709	1,109	786,010
1976	834	810	1,058	857,100
1977	2,321	2,205	1,252	2,760,470
1978	2,840	2,798	1,365	3,817,920
1979	5,555	5,410	1,349	7,296,110
1980	3,910	3,683	1,016	3,741,640
1981	3,865	3,811	1,177	4,487,410
1982	4,815	4,724	1,129	5,332,820
1983	3,110	3,063	1,044	3,198,500
1984	3,754	3,692	1,014	3,744,530
1985	3,055	2,844	1,109	3,153,020
1986	2,025	1,955	1,369	2,675,750
1987	1,805	1,775	1,469	2,608,150
1988	2,038	1,921	933	1,791,970
1989	1,840	1,786	985	1,759,760
1990	1,905	1,851	1,229	2,274,405
1991	2,743	2,670	1,352	3,609,990

Source: U.S. Department of Agriculture, National Agricultural Statistics Service. *Crop Production*. Annual and monthly issues, 1962-92.

Sunflowers were touted as "one of the most promising growth crops" as the decade drew to a close, and U.S. acreage projections of 10 million were not uncommon (Kleingartner, 1988). Besides providing a profitable cash crop alternative to small grains, sunflower cultivation offered a number of advantages, particularly to producers in the Northern Plains: a short growing period, drought tolerance, and a developing crushing industry to purchase the product.

Interest in sunflowers was also increasing in other areas with longer growing seasons. In Texas, for example, sunflowers were successfully introduced as a replacement crop for damaged or prevented cotton crops. Sunflower production in the area was well positioned for growing trade with Mexico while also providing local oilseed processors with an alternative oilseed for their existing crushing capacity.

Sunflower acreage failed to expand as expected in the 1980's, despite optimistic projections. Acreage dropped off significantly in 1980 and ranged between 3.1 and 4.8 million acres through 1985. Acreage declined sharply again in 1986, fell below 2 million acres in 1987, and remained at this level until turning up in 1991. Acreage declined in the 1980's, due in part to the reversal of the very factors that had led to the earlier expansion:

- Sunflower prices leveled off and then declined as world oilseed and product competition intensified, especially in the European Community.
- Aided by rising Government income supports, U.S. wheat and barley returns increased, making sunflowers a less attractive crop alternative.
- The increased yields associated with new cultivars came with increased production costs, while the continued concentration of sunflower production and lack of rotation increased susceptibility to pest and disease attacks.

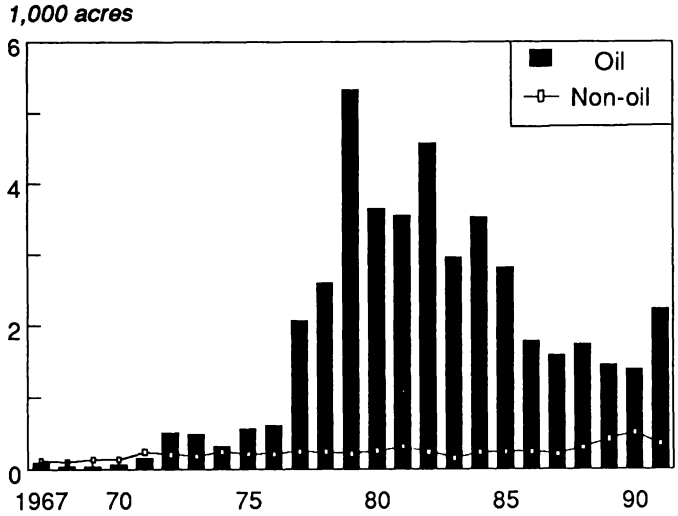
The outlook for sunflower acreage in the 1990's is more bullish, driven by recent changes in farm policy that allow farmers to respond more promptly to market conditions. Farmers in the five principal sunflower producing States planted 2.6 million acres of sunflowers in 1991, up nearly 700,000 acres from 1990. Although this increase in acreage was driven in part by low early season wheat prices and improved soil-moisture conditions, changes in Federal policy increased the relative attractiveness of sunflowers (see Policy and Programs section). The shift in Federal policy and growing markets at home and abroad for sunflowerseed products could support sunflower acreage in the 1990's.

Oil and Confection

Oil-type sunflowers are primarily grown to be crushed and to produce a high-quality vegetable oil. Oil varieties also find a ready market among bird-food manufacturers where they hold a preferred status due to the higher energy content of the seed and thinner hulls. Confection varieties are primarily used in the manufacture of products such as roasted nuts, candies, and baked goods. Confections are also used in bird-food mixes and can be used by the crushing industry.

Acreage seeded with oil varieties declined through much of the 1980's after increasing rapidly through the 1970's (fig. 3). Acreage planted with non-oil varieties steadily in-

Figure 3
U.S. sunflower planted acreage, by type, 1967-91



Source: Data from USDA, National Agricultural Statistics Service. *Crop Production.* Annual issues, 1968-92.

creased during this same period, driven by growing consumer demand that resulted in attractive contract prices. Non-oil sunflowerseed varieties were planted on an estimated 515,000 acres in 1990, the largest planting on record, accounting for more than 25 percent of all sunflower acreage. High-oil-yielding varieties dominated the increase in sunflower acreage in 1991, due in part to a buildup in confection stocks that led to lower contract prices in the spring (USDA, *Agricultural Statistics, Crop Production*, various issues). U.S. sunflowerseed production was 84 percent oil type and 16 percent confection in 1991 (USDA, *Crop Production*, Jan. 1992).

Yields

Yields are typically characterized by the number of pounds, bushels, or tons of seed annually produced from an acre or hectare of land. The principal components of yield for sunflowers include the number of heads per acre, the number of seeds per head, and the weight of those seeds.

The number of heads per acre is determined by plant populations because commercial sunflowers typically support a single head. Plant populations are determined by seeding rates. However, higher populations do not necessarily guarantee larger yields. Like most plants, increased sunflower populations may cause reductions in seed sizes, seeds per head, and seed weight (Robbinson, 1978). The optimal seeding rate is difficult to generalize as it depends on soil characteristics and management practices. Also, because of differences in growth characteristics between oil and confection varieties, the optimal plant population will vary with the planned end use of the seed.

Average U.S. seeding rates remained relatively constant between 1981 and 1990, ranging between 19,600 and 20,600 seeds per acre. These rates use about 3 to 5 pounds of seed per acre, depending on seed type and variety. Seeding rates are higher on richer soils or when the crop is irrigated.

Seed genetics, climate, soil quality, and management practices influence sunflower yields. While seeding rates have remained relatively consistent, technological innovations and improvements in management practices have enhanced overall yield performance. Adverse weather and pest problems have occasionally depressed upward trending yields.

The introduction of high-oil-content Soviet cultivars in the late 1960's was one of the first major technological innovations in domestic sunflower production (Putt, 1978). With more seeds per head and higher oil yields per seed, these cultivars increased the expected yields and value of production.

A true hybrid sunflowerseed was introduced to U.S. commercial producers in 1972. The best hybrids boosted yields to 20 percent more than their openly pollinated counterparts. Since 1972, gradual progress in seed genetics, combined with advancements in disease control and improved management practices, has increased sunflower yields. As a result, average yields increased from 827 pounds per acre in 1965 to 1,469 pounds in 1987 (table 2).

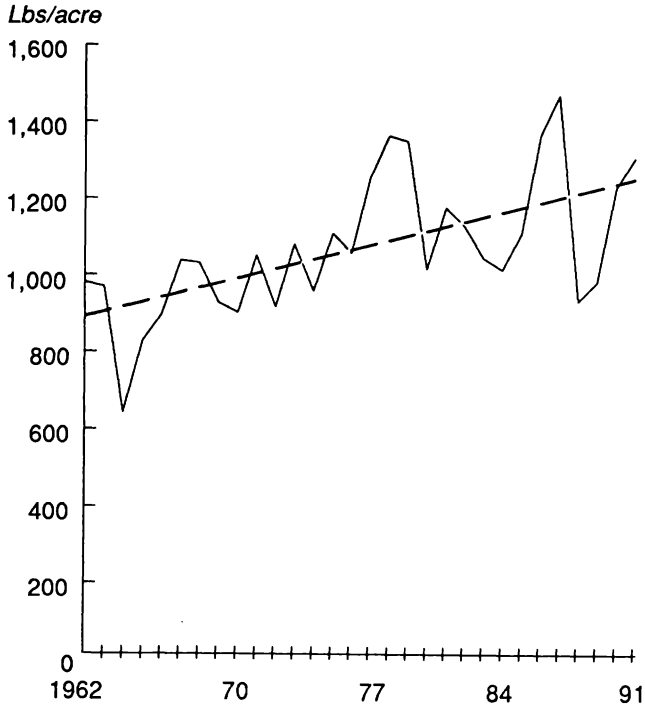
Yields may vary significantly with variations in weather, shifts in the location of production, and outbreaks of diseases or pests. Average yields fell from 1,365 pounds per acre in 1978 to 1,014 pounds per acre in 1984 before rebounding in 1985. The movement of sunflower production out of the more productive regions, such as the Red River Valley of North Dakota and Minnesota, combined with significant pest outbreaks, contributed to much of the decline over this period.

Droughts in 1988 and 1989 had a similar effect on yields. Average per acre yields dropped more than 500 pounds to 933 pounds between 1987 and 1988 (fig. 4). Yields recovered slightly in 1989 but remained well below trend. Yields continued to increase in 1990 and 1991 as soil-moisture conditions improved.

Production

Sunflower production rose steadily from 1965, peaking in 1979 at 7.3 billion pounds, as both yields and acreage increased (table 2). Production dipped dramatically in 1980 in response to poor growing conditions and a decline in acreage, but recovered somewhat in 1981 and again in 1982.

Figure 4
U.S. sunflowerseed yields, 1962-91



Source: Data from USDA, National Agricultural Statistics Service. *Crop Production*. Annual issues, 1962-92.

Sunflower production has declined steadily since 1982 to a 1989 low of less than 1.8 billion pounds, primarily due to declining acreage and drought-reduced yields. Sunflower production expanded in 1990 to roughly 2.3 billion pounds as yields recovered and acreage expanded. Production surpassed 3.6 billion pounds in 1991, driven by higher yields and larger acreage.

Production Practices

Production practices attempt to enhance the growing conditions for sunflowers to approach seed stock potential at the least cost and with minimal risk. The selection of specific practices, such as planting and harvesting dates, input mixes, and machinery choices, varies according to the climate, site, and soil characteristics as well as individual producer preferences and resources. However, there are a few generalizations that can be observed.

Planting and Harvesting Dates

Sunflowers are usually sown as a row crop in the United States, using practices common for corn or soybeans. Drilling, which reduces the distance between plants and rows (making further cultivation impractical), and broadcasting seed have been effective in certain areas although these techniques are less common. Planting dates are relatively flexible because the growing season in most areas is longer than the time needed for plants to reach maturity. In the Northern United States and Canada, optimal planting time is believed to be May 1 to May 20, but planting can extend into June in the event of wet weather or logistical constraints. Mid-March through April plantings provide the highest yields and oil percentages in the Southern United States (Robbinson, 1978).

Double-cropping sunflowers after crops such as winter wheat can push planting dates into June, although yields tend to suffer (Robbinson, 1978). In extreme cases, sunflowers have been seeded as late as September in parts of the Southeast after harvesting spring-sown crops such as corn (Lilleboe, 1990a).

Sunflowers are harvested about 4 months after planting, usually from late September through early November. Harvesting starts earlier for March/April-planted sunflowers. Harvest dates can be pushed up when seed shattering or birds present a risk to yields, or delayed when the harvest of more frost-sensitive crops takes priority.

Inputs

Inputs such as irrigation water, fertilizers, quality seeds, pesticides, labor, and machinery play an important role in assuring the quantity and quality of sunflower yields. The choice and mix of these inputs largely depend on location, as well as the cost of the inputs relative to the expected gains from their use. Certain inputs, such as labor and machinery or machinery and pesticides, can often be substituted for one another depending on their relative availability, efficiency, and cost.

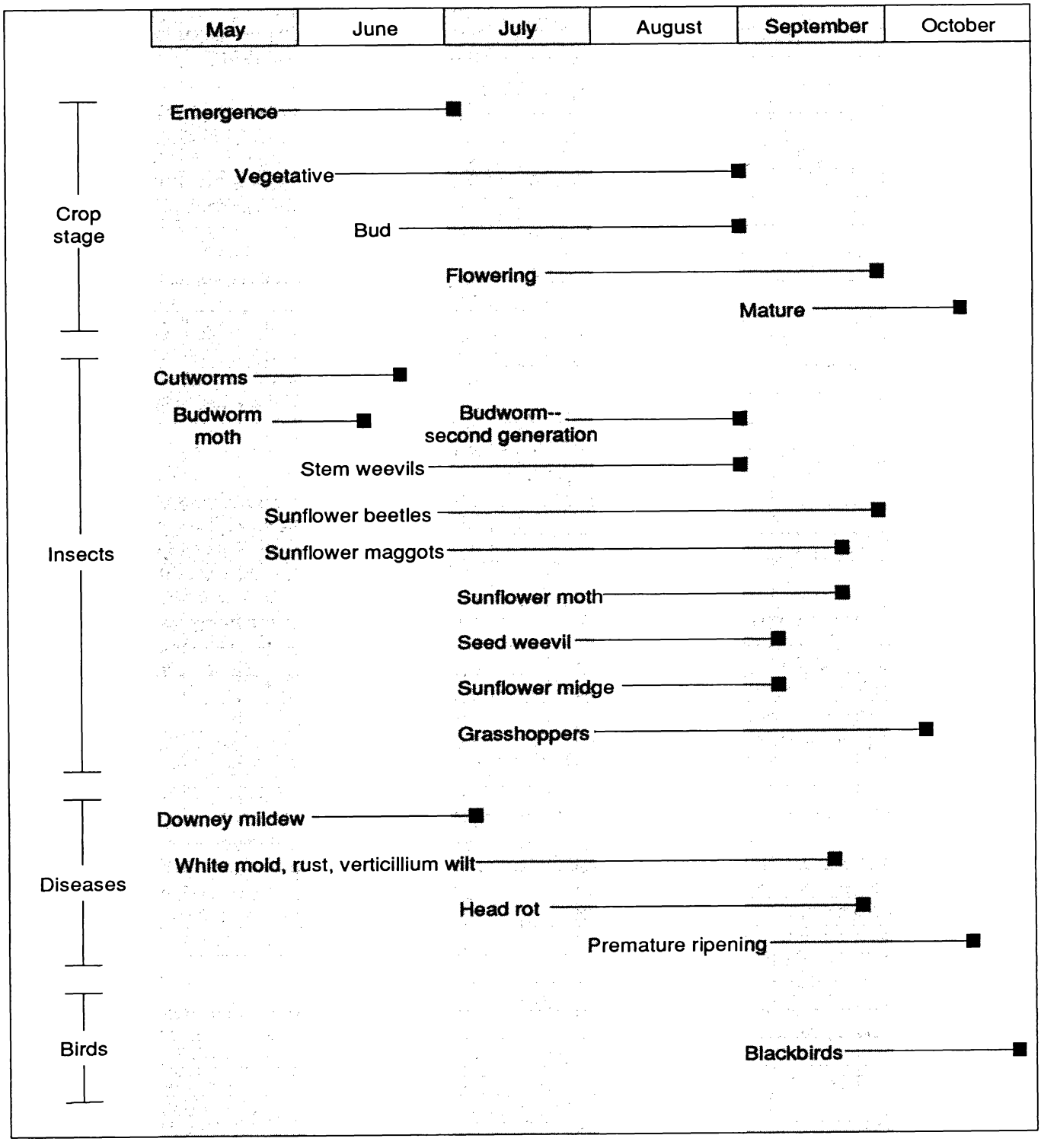
Sunflowers are not highly efficient water users, but may suffer less damage than other plants in drought years because of their deep and extensive root system. Consequently, sunflowers are commonly grown as a dryland crop, reserving irrigation capacity for less drought-tolerant crops. However, sunflower yields respond well to irrigation, increasing yields as much as 100 percent on certain soils. Yields have been found to be most responsive to water 20 days before to 20 days after flowering (Robbinson, 1978).

About 2 percent of all sunflower acreage was irrigated in 1987. Irrigation is more prevalent in the southern and western growing regions, due in part to the availability of low-cost water. California reported the highest percentage of irrigated acreage in both 1982 and 1987, 91 percent and 71 percent, respectively (U.S. Dept. of Commerce, *1987 Census of Agriculture*, Part 51, Table 24, p. 333).

Fertilizers are used to compensate for nutrient deficiencies in soils. Nitrogen is the most common element limiting sunflower yield although increasing application rates can reduce the oil content of the seed. Application of phospho-

Figure 5

Sunflower growth and pest occurrence sequence



Marcia P. McMullen. Ed. *Sunflower Production and Pest Management.* Extension Bulletin 25 (rev.). North Dakota State University, Dec. 1985, p. 18.

rous increases oil content while reducing oil saturation levels (Robbinson, 1978). Expenditures on all fertilizer accounted for roughly 20 percent of variable cost expenses from 1985 to 1988 (McElroy and others, 1989; USDA, *Cost of Production*, 1990).

Species of seed and stem weevils, grasshoppers, and various sunflower moths and midges are common insect problems in sunflowers (fig. 5). Sclerotinia wilt has been the most problematic disease for sunflower producers, although downey mildew, rust, Phoma black stem, head rot, and Verticillium wilt have also been noted as major disease problems. Birds, especially blackbirds, and weeds can also reduce sunflower yields. A buildup of diseases such as Sclerotinia and insects such as the midge and seed weevil in the late 1970's and 1980's, and the high costs of control, contributed to the decline of sunflower acreage in the Red River Valley (Lilleboe, 1990b).

The amount of pesticides used varies from year to year and by location because pest risk is weighed against the economics of control. From 1979 to 1988, farm chemicals accounted for approximately 20 percent of variable cash expenses. The percentage has dropped in recent years from a high of nearly 30 percent in the early 1980's to 20 percent in 1988 (McElroy and others, 1989; USDA, *Cost of Production*, 1990).

Desiccants (drying agents) can be employed after the crop matures to speed the drying process and compress the growing season. Like frost, drying agents kill the remaining green tissue. However, application before the plant matures may reduce yields and oil content (McMullen, 1985).

Machinery requirements for planting sunflowers do not differ greatly from those for other row crops, although individual practices can vary according to soil and site requirements. Farmers specializing in small grain production may consider the addition of a grain planter, although small grain drills and broadcasting have proved effective in some cases. Sunflowers can be harvested with small grain combines after adding specialized pans to reduce seed loss and shattering.

Rotations

Crop rotations reduce the risk of pest attacks, improve soil characteristics, and reduce chemical input requirements and costs. In the Northern United States, sunflowers are often rotated with small grains such as wheat, barley, and oats, and also with potatoes, sugar beets, and beans. Sunflowers can improve overall use of water and nutrients because the plants extract these elements from deeper soil depths than do shallow-rooted plants. After severe pest problems during the late 1970's and early 1980's, the length of crop rotations has been extended; agronomists often recommend a minimum 4-year rotation with sunflowers. There are, however, some limitations. For example, because other oilseeds such as canola, rapeseed, flax, and mustard harbor similar pests, successive rotations with sunflowers may increase rather than reduce the risk of attack.

Farm Characteristics

The 1987 Census of Agriculture recorded 11,741 farms that harvested roughly 2 million acres of sunflowers. This acreage produced 2.6 billion pounds of seed for a total farm value of $181.5 million. Although 29 States reported sunflower production, three States—North Dakota, South Dakota, and Minnesota—accounted for 90 percent of national production. North Dakota alone accounted for 73 percent of sunflower production.

Table 3--Distribution of farms growing sunflowers, by acres harvested, 1987

State	Acres of sunflowers harvested							Farms
	1-24	25-49	50-99	100-249	250-499	500-999	1,000 or more	
	Percent							*Number*
North Dakota	4	10	22	38	18	6	1	7,043
South Dakota	8	18	27	29	11	4	2	1,659
Minnesota	13	19	24	33	8	2	1	683
Other	25	19	24	25	6	1	1	2,356
U.S. total	9	14	23	34	14	5	1	11,741

Source: U.S. Department of Commerce, Bureau of the Census. *1987 Census of Agriculture*. Geographic Area Series, Vol. 1, Parts 23, 34, 41, and 51, Table 44, Nov. 1989, p. 36.

Table 4--Distribution of farms growing sunflowers, by sales class, 1987

State	Less than $20,000	$20,000 to 39,999	$40,000 to 49,999	$50,000 to 99,999	$100,000 or more	Farms
	Percent					Number
North Dakota	3	23	9	34	31	7,043
South Dakota	3	21	8	28	39	1,659
Minnesota	6	18	7	29	39	683
Total	3	23	9	32	33	9,385

Source: U.S. Department of Commerce, Bureau of the Census. *1987 Census of Agriculture*. Geographic Area Series, Vol. 1, Parts 23, 34, and 41, Table 52, Nov. 1989, pp. 116-17.

Table 5--Distribution of farms growing sunflowers, by standard industrial class, 1987

State	Cash grain	Field crops (noncash grain)	Livestock and animal specialties	General farm primarily: Crops	General farm primarily: Livestock	Farms
	Percent					Number
North Dakota	89	1	8	1	1	7,043
South Dakota	61	1	33	3	2	1,659
Minnesota	85	5	7	2	1	683
Total	84	1	13	1	2	9,385

Source: U.S. Department of Commerce, Bureau of the Census. *1987 Census of Agriculture*. Geographic Area Series, Vol. 1, Parts 23, 34, and 41, Table 53, Nov. 1989, pp. 136-37.

Table 6--Distribution of farms growing sunflowers, by type of organization and tenure of producers, 1987

State	Organization: Individual proprietorship	Organization: Partnership	Organization: Corporation	Tenure: Full owner	Tenure: Part owner	Tenure: Tenant	Total
	Percent						Number
North Dakota	88	11	1	16	67	18	7,043
South Dakota	84	11	5	16	68	16	1,659
Minnesota	79	15	6	22	65	14	683
Total	87	11	2	16	67	17	9,385

Source: U.S. Department of Commerce, Bureau of the Census. *1987 Census of Agriculture*. Geographic Area Series, Vol.1, Parts 23, 34, and 41, Tables 48 and 49, Nov. 1989, pp. 48 and 58.

Forty-six percent of those farms with sunflower acreage nationally harvested fewer than 100 acres, 34 percent harvested between 100 and 249 acres, and 20 percent harvested 250 acres or more (table 3). In the three leading States, operations tended to be larger, averaging 176 harvested acres per farm with 23 percent harvesting more than 250 acres. In contrast, the number of sunflower acres harvested per farm in all other States averaged less than 100 acres with only 7 percent harvesting more than 250 acres. Nationally, the average number of acres harvested per farm, however, has declined since 1982.

The 1987 Census of Agriculture surveyed sunflowers as a principal crop in only three States: North Dakota, South Dakota, and Minnesota. The census listed organizational structure, tenure, and industrial and sales classification statistics for these States (tables 4-6). Eighty-seven percent of farms were owned by families or individuals, 11 percent by partnerships, and 2 percent by corporations (table 6). Corporate farms in Minnesota and South Dakota tended to control more acreage, averaging 317 acres harvested per farm compared with 184 acres for individual proprietorships and partnerships.

An operator either works on the farm directly or makes the day-to-day decisions concerning planting, harvesting, feeding, and marketing. An operator may include members of the owner's household, a hired manager, a renter, or a sharecropper. Unlike the national trend, the majority of farms growing sunflowers in these three States were operated by part owners (67 percent), followed by tenants (17 percent), and full owners (16 percent) (table 6). Nationally, the majority of farms were operated by full owners.

Cash grains, primarily wheat, barley, corn, and soybeans, dominate crop production in these three States (table 5). Eighty-four percent of the farms growing sunflowers were classified as cash grain farms in 1987. Few farms specialize in growing solely sunflowers because of the limited market for sunflower products and agronomic constraints. Rather, sunflowers are rotated with grains and other specialty crops adapted to the region. South Dakota, with a larger percentage of range and animal feeding operations, diverged noticeably from this pattern.

Costs and Returns

Profitability is an important determinant for crop selection and management decisions. The bottom line for any crop is difficult to generalize and can vary widely among individual operations as well as among areas where the crop is grown. Average receipts and cost components for major crops in specific regions are available from USDA's *Economic Indicators of the Farm Sector*. For sunflowers, the survey is available only for North Dakota, South Dakota, and Minnesota, and was discontinued in 1989. This series includes average sales and prices received by farmers, the cost components applicable to sunflower production in these States, as well as whole-farm financial data to incorporate costs such as overhead and interest that are not enterprise (or acre) specific.

Total returns from sunflower production vary from year to year as yield and prices change. Total returns have ranged between $97 and $126 per acre between 1979 and 1988 (table 7). Fluctuating yields and prices have limited the gain in total receipts over this period.

Production costs also vary over time as input prices and quantities change. Cash expenses are either variable (costs incurred only when the crop is produced) or fixed (costs that do not vary with output). Between 1985 and 1988, seed was the largest single variable cost, followed by chemicals, fertilizers, and machinery repairs. Chemicals typically represented the largest component of variable cost prior to 1985. Chemical costs, as well as fuel and lubricant costs, are sensitive to petroleum prices and can escalate rapidly in response to disturbances in these markets. Average variable costs in North Dakota, South Dakota, and Minnesota have declined since 1983, due in part to declines in fuel and chemical expenditures.

Fixed costs include general farm overhead, taxes and insurance, and interest on loans and real estate. While these costs are not necessarily specific to activities on individual acres, they do affect farm profitability and longer term investment decisions. Total fixed costs for the farm are allocated across individual activities according to their share in total production value (for farm overhead) or according to the relative share of acreage allocated to their production (for taxes, interest, and insurance). Average fixed costs have ranged from a low of $23 per acre in 1979 to a high of $38 per acre in 1983. Interest payments represented the largest single fixed cost throughout the period.

Receipts less cash expenses (variable plus fixed costs) represent a shortrun return to production and measure the amount of cash left over to cover longer term costs (McElroy and others, 1989). Returns ranged from $16.73 to $54.83 per acre from 1979 to 1988, averaging $28.50 per acre. Returns have trended upward since 1988, driven by higher market prices and declining variable costs. Industry estimates of sunflower-producing counties in North Dakota and South Dakota indicated that receipts less variable costs for 1990 (latest data available) were projected to range between $53.86 and $71.00 per acre (Kleingartner, 1990).

To put these returns in perspective, we compare market receipts less cash expenses for sunflowers with those for wheat and barley in the Northern Plains in figure 6. Wheat and barley are the predominant crops in this area and often compete with sunflowers for available farm resources. With the exception of 1982, per acre shortrun returns from

Table 7--U.S. sunflower production costs, 1979-88

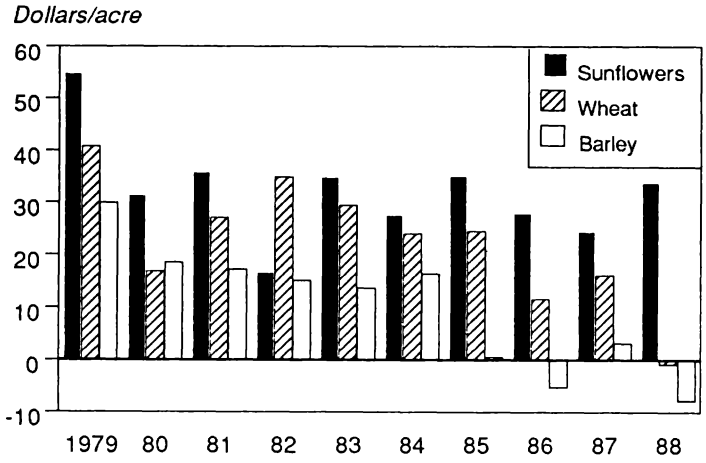
Item	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
					Dollars/planted acre					
Gross value (total returns)	116.55	100.01	119.46	96.67	125.74	115.38	108.11	97.72	98.37	102.92
Cash expenses:										
Seed	5.53	5.82	6.38	6.73	8.80	9.36	11.38	12.86	12.79	12.09
Fertilizer	9.18	11.44	11.02	10.10	9.04	9.77	9.90	8.49	7.52	8.46
Chemicals	6.50	6.88	7.31	13.83	14.55	14.80	8.53	8.47	8.65	8.86
Custom operations	1.98	2.20	2.50	1.88	1.90	1.95	2.62	2.62	2.75	2.90
Fuel, lube, and electricity	6.57	9.24	10.90	9.99	8.62	6.55	7.36	4.42	5.55	5.02
Repairs	5.85	6.57	7.91	6.00	6.24	5.93	5.35	5.37	5.42	5.28
Hired labor	1.27	1.35	1.55	1.33	1.32	1.37	1.21	1.33	1.25	1.24
Drying	2.11	1.61	2.07	2.41	2.30	1.95	2.13	2.68	2.88	1.68
Miscellaneous	0	0	0	.01	.01	.01	0	0	0	0
Technical services	0	0	0	.40	.38	.36	.35	.34	.34	.34
Total, variable cash expenses	38.99	45.11	49.64	52.68	53.16	52.05	48.83	46.58	47.15	45.87
General farm overhead	6.88	5.90	7.43	5.44	8.21	8.36	4.72	5.22	7.55	7.28
Taxes and insurance	5.34	6.04	6.43	5.76	5.92	6.06	6.24	6.67	6.72	6.43
Interest on operating loans	4.94	5.93	10.89	7.03	12.05	12.53	5.88	5.22	4.08	3.67
Interest on real estate	5.58	5.61	9.23	9.03	11.55	10.11	7.38	6.13	8.29	6.60
Total, fixed cash expenses	22.73	23.48	33.98	27.26	37.73	37.06	24.22	23.24	26.64	23.98
Total, cash expenses	61.72	68.59	83.62	79.94	90.89	89.11	73.05	69.82	73.79	69.85
Gross value less cash expenses	54.83	31.42	35.84	16.73	34.85	26.27	35.06	27.90	24.58	33.07
Capital replacement	16.56	17.90	20.98	19.16	19.86	18.44	18.31	19.00	18.92	19.02
Gross value less cash expenses and replacement	38.27	13.52	14.86	-2.43	14.99	7.83	16.75	8.90	5.66	14.05
Economic (full ownership) costs:										
Variable cash expenses	38.99	45.11	49.64	52.68	53.16	52.05	48.83	46.58	47.15	45.87
General farm overhead	6.88	5.90	7.43	5.44	8.21	8.36	4.72	5.22	7.55	7.28
Taxes and insurance	5.34	6.04	6.43	5.76	5.92	6.06	6.24	6.67	6.72	6.43
Capital replacement	16.56	17.90	20.98	19.16	19.86	18.44	18.31	19.00	18.92	19.02
Allocated returns to owned inputs--										
Return to operating capital	1.09	2.01	2.61	2.06	1.67	1.87	1.41	.95	1.05	1.23
Return to other nonland capital	3.78	3.71	3.97	3.20	3.01	3.60	3.32	3.47	3.85	4.26
Net land return	30.36	27.42	31.85	29.15	32.75	31.18	29.74	26.66	25.52	26.64
Unpaid labor	5.40	5.76	6.60	5.65	5.62	5.82	5.16	5.65	5.34	5.31
Total, economic costs	108.40	113.84	129.50	123.10	130.20	127.38	117.73	114.20	116.10	116.04
Residual returns to management and risk	8.15	-13.83	-10.05	-26.43	-4.46	-12.00	-9.62	-16.48	-17.73	-13.02
Harvest-period price (dollars/cwt)	8.83	10.41	10.28	8.76	12.23	11.59	10.54	7.39	6.80	12.36
Yield (cwt/planted acre)	13.20	9.61	11.62	11.04	10.28	9.95	10.26	13.23	14.47	8.33

Sources: Robert McElroy, Mir Ali, Robert Dismukes, and Annette Clauson. *Costs of Production for Major U.S. Crops, 1975-87.* Staff Report AGES 89-22. U.S. Dept. Agr., Econ. Res. Serv., Table 38, May 1989, p. 41.

U.S. Department of Agriculture, Economic Research Service. *Cost of Production: Major Field Crops, 1988.* ECIFS 8-4. Table 50, Apr. 1990, p. 68.

Figure 6

Comparative crop returns, Northern Plains, 1979-88



Note: Returns are revenues less cash expenses, excluding Government payments.

Source: Data from Larry Kleingartner. Ed. "Boost Your Cash Flow with Sunflower Power," *The Sunflower*, Vol. 16, No. 2, Feb. 1990, p. 17.

sunflowers were higher than those for either wheat or barley (excluding Government payments), averaging nearly $12 per acre higher than wheat and $22 per acre higher than barley from 1979 to 1988. Despite volatile world oilseed market conditions, sunflower returns were no more variable than wheat returns and less variable than barley returns over this period.

Sunflowerseed Processing and Product Characteristics

Oil-type sunflowerseeds are processed to produce sunflowerseed oil and sunflowerseed meal. Sunflowerseed oil is a vegetable oil used in food manufacturing, as a frying oil, and in margarine and spreads. Sunflowerseed meal is primarily used as a high-protein livestock feed ingredient. The hulls represent a third product of sunflowerseed processing and have economic value but few formal markets. Sunflowerseed processors, also called crushers, buy seeds and convert them to oil and meal.

Sunflowerseed Oil

Sunflowerseed oil is a food product and is primarily used in the manufacture of margarine, salad and cooking oils, and shortenings. Sunflowerseed oil shortenings are commercially used for baking or frying and, in liquid form, the oil is bottled and sold as a cooking and salad oil. The liquid form can also be used for commercial cooking or frying, or can be manufactured into salad dressings or mayonnaise. Sunflowerseed oil substitutes for soybean, cottonseed, corn, and canola oils. Like most other vegetable oils, the fatty acids in sunflowerseed oil can be industrially used in the manufacture of detergents, paints, lubricants, and other products. However, industrial use of sunflowerseed oil is limited by cheaper animal fat or vegetable oil sources for fatty acid components.

Crude sunflowerseed oil is amber, while refined oil is light yellow and similar in appearance to soybean and corn oils. The composition of sunflowerseed oil is more sensitive to the influence of climate, temperature, genetics, and even the position of seed location on the flower than other vegetable oils.

Sunflowerseed oil is relatively low in saturated fats at 10.3 percent, compared with corn oil at 13.9 percent, soybean oil at 14.0 percent, and palm oil at 52.1 percent (table 8). Only canola oil at 6.5 percent and safflower oil at 10.0 percent saturated fat are lower. Saturated fat is associated with high serum cholesterol levels and heart disease in some people.

Sunflowerseed oil is 14.3 percent monounsaturated fat (oleic acid) and 75.4 percent polyunsaturated fat (linoleic acid). Vegetable oils containing over 2 percent linolenic acid (another polyunsaturated fat), such as canola oil (8.2 percent) and soybean oil (8.3 percent), tend to develop off-flavors because the linolenic acid oxidizes quickly. Sunflowerseed oil, cottonseed oil, and palm oil contain no linolenic acid, while corn oil contains only 0.8 percent. Oils with higher percentages of linolenic acid are often partially hydrogenated (saturated) to enhance stability and shelf life. This process is not necessary with sunflowerseed oil. The absence of linolenic acid in sunflowerseed oil also enhances its attractiveness as a frying oil. Chemical reactions with heated linolenic acid cause residue buildup in commercial frying uses.

The fatty acid content of sunflowerseed oil varies slightly depending on where it is grown (National Sunflower Association, 1985). This change is unique to sunflowerseed oil. Sunflowerseed oil from flowers grown in Northern States will have slightly higher amounts of polyunsaturated fat and a lower percentage of monounsaturated fat than oil from sunflowerseed grown in southern climates. These differences do not affect the oil's performance. Recent genetic advancements have led to the development of varieties higher in monounsaturated fat that are readily adaptable to northern climates.

Table 8--Characteristics of sunflowerseed oil and major substitutes

Fatty acid profiles	Canola oil	Safflower oil	Sunflower-seed oil	Corn oil	Soybean oil	Cotton-seed oil	Palm oil
				Percent			
Saturated:							
Arachidic	0.5	0.5	--	0.2	0.2	--	0.2
Lauric	--	--	--	--	--	--	.1
Myristic	--	.1	--	--	.1	1.0	1.2
Palmitic	4.3	6.7	7.0	11.5	10.5	25.0	46.8
Stearic	1.7	2.7	3.3	2.2	3.2	2.8	3.8
Monounsaturated:							
Eicosenoic	--	.5	--	--	.9	--	.3
Erucic	.9	--	--	--	--	--	--
Gadoleic	2.0	--	--	--	--	--	--
Margaric	.1	--	--	--	--	--	--
Margaroleic	.1	--	--	--	--	--	--
Oleic	59.1	12.9	14.3	26.6	22.3	17.1	37.6
Palmitoleic	.3	--	--	--	--	.7	--
Polyunsaturated:							
Linoleic	22.8	77.5	75.4	58.7	54.5	52.7	10.0
Linolenic	8.2	--	--	.8	8.3	--	--
				Centigrams/gram of fat			
Iodine value[1]	114	143.3	125-136	124	120-141	97-115	48-56

-- = Not applicable.
[1]Iodine value refers to the number of centigrams of iodine absorbed by 1 gram of fat. The test is used to evaluate and define shortening products.
Source: Theodore J. Weiss. *Food Oils and Their Uses*. 2nd ed. Westport, CT: AVI Publishing Co., 1983, pp. 36, 38, 40, 42, 44-46, 48, and 49.

Table 9--Sunflowerseed meal characteristics

Meal	Crude protein	Fiber	Key amino acids: Methionine	Key amino acids: Lysine	Key amino acids: Tryptophan	Ruminant TDN[1]	Swine ME[2]	Poultry ME[2]
	Percent						*Cal/kg*	
Sunflower (expeller)	41	13.0	1.60	2.0	0.6	61	2,715	2,310
Sunflower (partially dehulled-solvent)	34	21.0	.64	1.4	.4	61	2,298	2,260
Canola	38	11.1	.70	2.3	.4	64	2,700	1,900
Soybean (solvent)	44	7.0	.65	2.9	.7	78	2,825	2,240
Soybean (hi-pro)	49	3.0	.75	3.2	.6	79	2,881	2,400
Corn gluten	60	2.5	1.90	1.0	.3	86	N/A	3,850

N/A = Not available.
[1]Total digestible nutrients. [2]Metabolizable energy.
Source: The Miller Publishing Co. "Ingredient Analysis Table, 1991 edition," *Feedstuffs*, Vol. 63, No. 29, July 18, 1991, pp. 28-30.

Sunflowerseed Meal

Sunflowerseed meal is used as a high-protein ingredient in livestock feed. Its close substitutes include soybean, cottonseed, corn gluten, canola, linseed, and fishmeals. Since most sunflowerseed is produced in the Northern United States, locally produced linseed and canola meals are the most likely substitutes. All of the aforementioned meals can be used as protein sources for livestock feed.

The amount of hulls retained in sunflowerseed meal affects the meal's protein level. Sunflowerseed meal produced from whole sunflowerseeds will contain roughly 28 percent crude protein and 25-28 percent fiber. Partially dehulled sunflowerseeds will yield a meal with 32-38 percent protein and 18 percent fiber. Completely dehulled seeds will yield a 40-42 percent protein product with only 12-14 percent fiber. Meal with 28-32 percent protein currently serves as a benchmark standard for pricing.

Sunflowerseed meal has a lower level of total digestible nutrients than soybean meal and a higher fiber content, even in the completely dehulled product (table 9). The level of net metabolizable energy in sunflowerseed meal is lower than that of soybean meal for either lactation, weight gain, or maintenance. The limiting amino acid in sunflowerseed meal is lysine. This limitation is not important in feeding ruminants, but when feeding swine or poultry, it is necessary to combine sunflowerseed meal with another protein source higher in lysine. New amino acid supplements, now commercially produced in the United States, have the potential to increase the marketability of sunflowerseed meal.

Feeding trials at North Dakota State University indicated that swine can be successfully fed rations using sunflowerseed if lysine requirements are met (Dinosson, Harold, and Johnson, 1981). Feed efficiency in terms of weight gain was less with 28 percent protein meal with its higher fiber content than with 41 percent protein meal. Low-protein, high-fiber sunflowerseed meal is, however, suitable as a dairy ration. Also, there are no known anti-nutritional factors in raw sunflowerseed meal that lower feeding efficiency.

Sunflowerseed Hulls

Sunflowerseed hulls can be fed as roughage extenders, although they are considered to be less digestible than most other forages. The hulls are 80-85 percent fiber, 3.5-9.5 percent protein, 5-6 percent fat, and 2-5 percent ash. The hulls can also be mixed with other feeds such as alfalfa in pelletized form and marketed as dairy feed.

High-oil sunflowerseed is produced primarily for its oil and meal products. But at times of low prices or damaged crops, sunflowerseed may be fed directly or stored as silage. Feeding trials at South Dakota State University and North Dakota State University found that lactating dairy cattle can do as well on a corn/sunflowerseed meal concentrate ration as on a corn/soybean meal concentrate ration with few dietary modifications (Schingoethe, 1984).

A limited rumen capacity, the demands of body maintenance, milk production, growth, and gestation have made preparation of dairy cattle rations more challenging. Dairy operators have frequently fed whole cottonseed in dairy rations as a high-energy food source since the late 1970's. Research has shown that if fat levels are kept below 6 percent of the ration (to minimize digestive problems), then the concentration of energy in the fat is particularly useful to lactating cattle (Marx, 1991). Sunflowerseed has an advantage of containing twice the fat per unit as cottonseed. Sunflowerseed can be easily substituted for whole cottonseed, full-fat soybeans, or animal fats. Research on sunflowerseed silage suggests it may have 90-95 percent of the feed value of corn silage in feeding dairy cattle (Schingoethe, 1984).

Sunflowerseed hulls can also be used as an in-plant energy source. In a processing plant, combustion of hulls can generate enough steam and electricity for processing as well as co-generation of salable electricity. The resulting ash contains potassium that can be used as fertilizer.

The Sunflowerseed Crushing Process

Oil content is the major consideration in determining the crushing technology to be used to extract the oil. Sunflowerseeds have an oil content typically over 40 percent and as high as 50 percent after the hulls are removed. In contrast, soybeans contain only 18 percent oil.

The two major crushing technologies used for processing oilseeds are mechanical and solvent extraction. The mechanical process uses a continuous feed expeller which presses the oil from the seeds by mechanical pressure. The expeller process is less energy efficient, has higher maintenance costs, and allows 3-10 percent more of the oil to remain in the cake than solvent extraction.

The solvent process uses a chemical to remove the oil from the seed. Solvent extraction is technically more efficient because it leaves little residual oil in the remaining cake. However, with oilseeds of greater than about 25 percent oil content, solvent extraction becomes economically inefficient because of the larger amounts of solvent required to remove the oil. A combination of mechanical and solvent processing has become the industry standard for sunflowerseed processing for these reasons.

Most modern sunflowerseed processing plants begin processing by drying and then dehulling, or decorticating, the sunflowerseed because a higher value meal can be obtained

by removing sunflowerseed hulls. Seeds being processed should be clean of debris and have a low-moisture content. Decortication is a process in which the seeds are separated into hulls and kernels. The seeds are then mechanically pressed between a moving rotor and a stationary plate. A screen separates the cracked hulls from the meats. Some plants use a new air dehuller in which seeds are blown against a cracking surface and an upward air stream separates hulls, dehulled kernels, and uncracked seeds based on the differing weights of the components.

The next step in processing, the flaking process, follows whether the seeds are dehulled or not. The seeds are first heated to between 180° to 240° F (68° to 101° C), further lowering the moisture content; they are then pressed through large rollers into flattened flakes breaking open the seed cells and making the oil more accessible. Actual oil extraction occurs in a mechanical press. These continuous feed devices use a screw press operation to press oil from the heated flaked cake. The remaining oil is then chemically extracted.

The solvent extraction stage washes the pressed cake with a hexane-based solvent in a large holding basket. The solvent washes the cake, allowing oil to leach out of the cake and combine with the solvent. The hexane solvent is an extremely volatile substance and must be completely removed from both the oil and the remaining cake before it can be recovered and reused.

The resulting crude sunflowerseed oil is then bulk packaged and shipped to refiners for further processing into edible oil products. The meal is moved to a desolventizer where heating removes the remaining solvent and the meal is toasted. The sunflowerseed meal is finally ground after being desolventized.

Oil Preparation: Refining, Bleaching, and Deodorizing

Gums, if left in the oil, can produce higher losses in the refining process and can also settle in stored oil. Degumming is accomplished through hydration, a process by which oil is mixed with water to isolate gums and other impurities that are later extracted through settling, filtering, or most commonly centrifuging. When removed and further refined, the gums can be sold as lecithin, although the market is usually well supplied by soya lecithin. Degumming the oil is usually done at the crush mill rather than the refinery because degumming, if done at all, is easier if using fresh oils.

Sunflowerseed oil, like other vegetable oils, is refined before it becomes a food product. Refining removes free fatty acids and other impurities, bleaching lightens the color of the oil, and deodorizing removes elements that can cause undesired flavors or odors in the oil.

The refining process treats the oil with alkali solutions, such as sodium hydroxide, converting almost all free fatty acids into oil-insoluble soaps. The soap stock is then drawn off and can be sold. However, there is less use for soap stocks today than 30 years ago because of the expanded use of detergents. As an alternative, the soap stock can be used as a source of industrial fatty acids.

The bleaching process lightens sunflowerseed oil by removing certain color-producing pigments. This process involves an adsorbent material such as Natural Bleaching Earth, sometimes called "Fuller's Earth," or manufactured materials consisting of bentonite of montmorillonite. Some degumming is accomplished during the bleaching process. The oil is combined with the material and heated to 220° to 230° F. The bleaching material containing the color pigments is then filtered off.

Further processing depends on the final product for which the oil is intended. The oil may be dewaxed, deodorized, or hydrogenated. Dewaxed oil is suitable for use in salad dressing and mayonnaise, or bottled and sold to consumers as a cooking oil. Oil does not need to be dewaxed before being hydrogenated. Hydrogenated vegetable oils are used in the manufacture of margarine, confectionery fats, and shortening.

Sunflowerseed oil contains considerable quantities of wax that are not completely removed by the primary dewaxing process. A second dewaxing step chills the oil in holding tanks, allowing the waxes to conglomerate. Diatomaceous earth is then added to the oil, which is then passed through filters with the waxes adhering to the filters.

Deodorization is a final step completed after hydrogenation or dewaxing. Deodorization removes contaminants that can affect the flavor of the oil. The process uses steam and pressure to strip the oil of unwanted elements. The materials removed include free fatty acids and various flavor and odor compounds, mostly alcohols, hydrocarbons, and compounds formed by decomposition of peroxides and pigments. The resulting oil has a bright, light-yellow color and a bland flavor. At this point, the product can be finished into liquid oil suitable for cooking or salad dressing or can be finished into a hydrogenated or partially hydrogenated product to be made into margarine or shortening.

Hydrogenation is a chemical reaction of the oil with hydrogen gas in the presence of a catalyst, usually nickel. This process accomplishes two quality changes: to raise the melting point to a higher temperature and to improve the stability of the product. Hydrogenation slows oxidation, which contributes to flavor deterioration. The effect is to transform unsaturated bonds in the fat molecule to saturated ones. Lightly hydrogenated oil can remain liquid at room temperature, but further hydrogenation makes the oil a solid at room temperature.

The Economies of Scale for a Sunflowerseed Crushing Plant

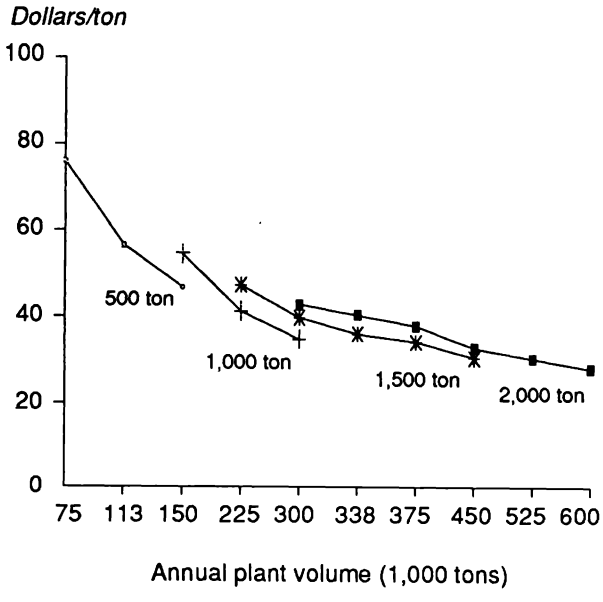
The profitability of sunflowerseed crushing ultimately determines the prices that manufacturers are willing to pay for oil-type seed. Profitability, however, depends on a number of factors, including the location of the plant relative to end-use markets, the availability of resources, labor costs, the cost of capital, and capital vintage.

In the short run, plant-use rates show a strong inverse relationship to average costs; the higher the use-capacity ratio, the lower the per unit costs. Economies of scale are also evident, as larger plants show lower per unit costs than smaller ones. With the exception of new dehulling capabilities, industry crushing technology is relatively stable. Basic extraction technology was perfected in the early 1950's and has changed little since that decade. The major innovation is that newer plants are much more energy efficient and environmentally safer.

Figure 7 illustrates the average cost per ton of sunflowerseed processed for the four sizes of plants. Costs are factory costs exclusive of raw materials costs, transportation, and byproduct credits. Plants are assumed to operate at full capacity (see appendix).

Figure 8 illustrates shortrun average cost curves when plants are operated at partial capacity. Illustrated are costs for 100, 75, and 50 percent of capacity averaged from the four different-sized plants. The results reinforce conclusions observed in other studies that there are strong economies of scale in oilseed processing.

Figure 7
Average sunflowerseed processing costs at full capacity, by annual plant volume



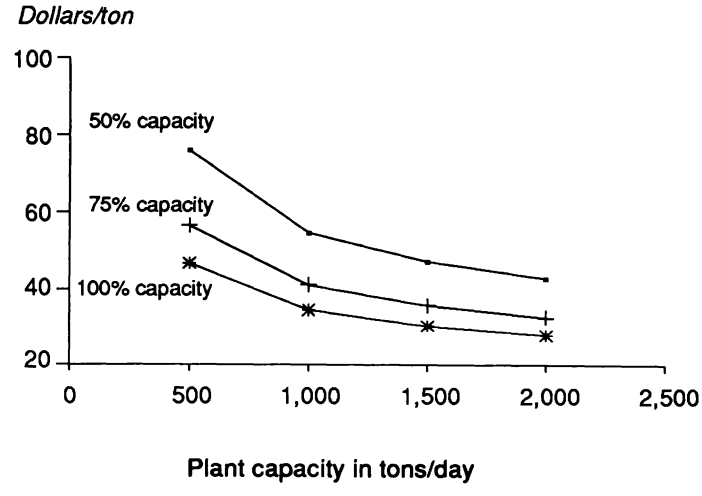
Source: Data from update of R. Sheithauer and K. Dripchak. *Economics of Vegetable Oil Processing.* Oak Ridge National Laboratory, 1985.

Strong economic reasons exist for operating at or near full capacity. Per unit costs are highly inversely related to capacity use. Operating a plant at partial capacity can significantly raise total unit costs. Assuming that the mill operator can purchase as much sunflowerseed as desired at the prevailing market price, there is a strong incentive to operate at or near full capacity to spread the fixed cost over as many units of output as possible. Plants can operate in the shortrun at a loss as long as variable costs are met even if crush margins do not cover the full costs. If variable costs cannot be met, shutdown occurs.

Crush Margins

The crush margin is the difference between the value of the crush products (the oil and the meal) and the cost of the sunflowerseed crushed. Many factors affect the actual crush margin a processor earns. Sunflowerseed oil and meal can be interchanged with other vegetable oils and other protein meals, soybean oil and meal being the most prominent. Consequently, market factors affecting U.S. soybean markets can have a substantial effect on U.S. sunflowerseed oil and meal prices. Other factors can directly affect the sunflowerseed market, but usually have little effect on the soybean market because the sunflowerseed market is small compared with the soybean market. A small sunflowerseed crop could raise seed prices to processors while an abundant supply of substitute protein meals could keep sunflowerseed meal prices low, consequently narrowing margins to processors.

Figure 8
Average sunflowerseed processing costs at partial capacities, by utilization rate



Source: Data from update of R. Sheithauer and K. Dripchak. *Economics of Vegetable Oil Processing.* Oak Ridge National Laboratory, 1985.

Prices in the vegetable oil and meal markets affect sunflowerseed processors in a different way than soybean processors. Because soybeans are 80 percent meal and dehulled sunflowerseed is only 40 percent meal by weight, strong demand for protein meals contributes more to the soybean processors' margin than to the sunflowerseed processors' margin. Dehulled sunflowerseed meal sells at a discount to soybean meal because of its lower protein content and lysine deficiency. However, sunflowerseed processors can benefit in strong oil markets because of the high oil content of sunflowerseed (40 percent oil) relative to soybeans (20 percent oil). Because it is the protein meal market that drives soybean crush, vegetable oil is often in surplus and prices can be low. This excess weighs heavily on sunflowerseed processors' margins.

Sunflowerseed and Sunflowerseed Product Demand

The demand for sunflowerseed is primarily derived from the demand for various end products. The market for seed is complicated by the two distinct classes of seed, oil-type and confection. While the two types are substitutable to a certain extent, each holds a comparative advantage in its respective end markets. The demand for sunflowerseed and its end products is also sensitive to macroeconomic factors. These include changes in income levels and interest rates that affect consumer demand and operating costs, as well as Government policies and exchange rates that affect domestic production and trade patterns.

Oil-Type Sunflowerseed

The demand for oil-type sunflowerseed is principally derived from its use as an input in sunflowerseed oil and meal production (crush). This processing includes domestic production as well as the demand for exported seed to be crushed in foreign facilities. The profitability of processing (margin) changes as the demand for sunflowerseed oil and meal expands or contracts. The demand for seed and the resulting price processors are willing to pay ultimately reflects the profitability of crushing operations.

Meal and hulls represent larger weight components of oil-type sunflowerseed than confection sunflowerseed. However, because of the higher prices, oil dominates in terms of overall seed value. For example, between 1978 and 1990, oil content ranged between 37 and 42 percent of the sunflowerseed crushed, while meal content ranged between 50 and 59 percent. During this same period, sunflowerseed oil accounted for an average 79 percent of the value of the products (table 10).

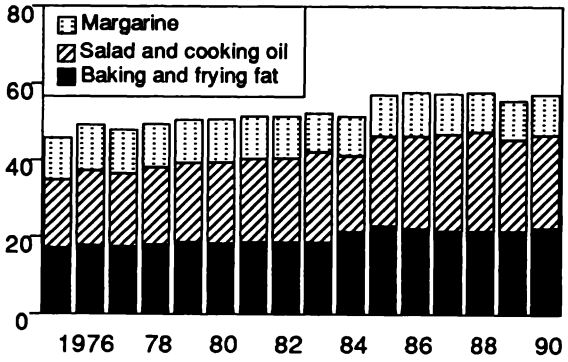
Table 10--Value of products per metric ton of sunflowerseed processed, marketing years 1978-90

Marketing year	Oil			Meal			Total value	Share of total value		Seed cost	Spread[1]
	Yield	Price	Value	Yield	Price	Value		Oil	Meal		
	Lbs/mt[2]	----- *$/mt* -----		*Lbs/mt*	---------- *$/mt* ----------			-- *Percent* --		---- *$/mt* ----	
1978/79	868	728	287	1,359	102	63	350	82	18	236	114
1979/80	903	575	235	1,447	106	70	305	77	23	198	105
1980/81	842	594	227	1,241	122	69	296	77	23	240	51
1981/82	808	550	201	1,185	117	63	264	76	24	238	26
1982/83	872	495	196	1,249	112	63	259	75	25	199	60
1983/84	762	741	256	990	123	55	311	82	18	287	25
1984/85	851	661	255	1,248	58	33	288	89	11	249	39
1985/86	867	421	166	1,168	76	40	206	80	20	175	31
1986/87	924	353	148	1,059	84	41	189	79	21	152	36
1987/88	923	520	218	1,044	109	51	269	81	19	184	85
1988/89	901	500	204	1,144	135	70	274	74	26	267	8
1989/90	867	538	212	1,058	111	53	265	80	20	234	31
1990/91	907	520	214	1,090	97	48	262	82	18	240	22

[1]Difference between the value of the products and the cost of the seed. Numbers may not add to totals because of rounding.
[2]mt = metric ton.
Source: Oil and meal yields calculated from U.S. Department of Commerce, Bureau of the Census. *M20-J* and *M20-K* reports. Monthly issues, 1979-91. Prices from appendix tables 2, 3, and 4. Original source: U.S. Department of Agriculture, Economic Research Service. *Oil Crops: Situation and Outlook Report*. July 1992, pp. 31-32.

Figure 9
U.S. per capita consumption of fats and oils, 1975-90

Pounds/capita



Source: Data from USDA, Economic Research Service. *Oil Crops: Situation and Outlook Report.* July 1992, p. 39.

Sunflowerseed oil and meal markets are complex, and the resulting prices necessary to clear these markets are closely tied to vegetable oil and animal feeds markets. This market similarity stems from the high degree of substitutability found among the various oils and meals. Foreign trade patterns and public policy choices that influence domestic markets also affect sunflowerseed oil, meal, and resulting seed demand.

Vegetable Oil Market

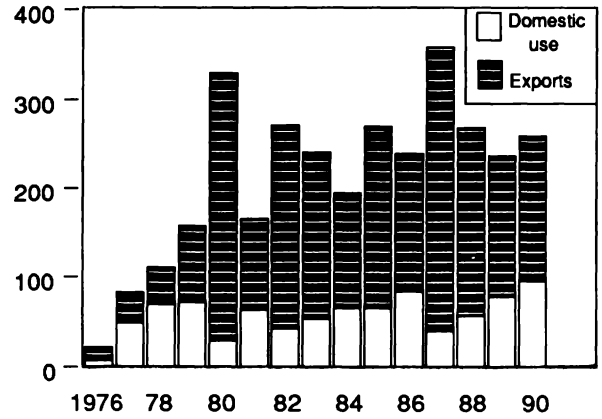
Sunflowerseed oil is chiefly used in edible products, such as salad and cooking oils, margarine, and baking and frying fats. A smaller percentage of oil is used in industrial products, such as plastics, paints, soaps, and animal feeds.

The availability and price of close substitutes, consumer income, population, attitudes towards health, and food preferences are major factors affecting vegetable oil demand. Policies that can enhance exports or restrict imports of competitive products also affect demand.

U.S. annual per capita consumption of fats and oils in food products (butter, edible lard and tallow, margarine, baking and frying fats, salad and cooking oil, and other edible uses) rose between 1975 and 1986 to a peak of 58 pounds, up 26 percent from 1975 (fig. 9). A rise in the use of salad and cooking oils and baking and frying fats dominated the increase. This rise is often associated with rising consumer incomes, increasing use of prepared foods, and increasing demand for restaurant services. Per capita consumption of fats and oils has stabilized since 1987 despite higher incomes, due in part to changing consumption patterns that have emphasized lower fat diets.

Figure 10
Composition of sunflowerseed oil consumption, marketing years 1976-90

1,000 metric tons



Note: Domestic use represents apparent disappearance.

Source: Data from USDA, Economic Research Service. *Oil Crops: Situation and Outlook Report.* July 1992, p. 39.

Sunflowerseed oil competes with other vegetable oils including soybean, cottonseed, and most recently, canola oil within the domestic market. Soybean oil has historically dominated the vegetable oil market, accounting for about 73 percent of the total fats and oils used in edible products between 1983 and 1990; in contrast, sunflowerseed oil accounted for less than 1 percent (USDA, *Oil Crops: Situation and Outlook Report*, Apr. 1992, Table 34).

Salad and cooking oil traditionally represent the largest component of domestic sunflowerseed oil demand. Salad and cooking oil accounted for 90 percent of the sunflowerseed oil used in domestic products in 1980 and 1981. Since then, sunflowerseed oil has made inroads into the baking and frying fats market, accounting for more than 25 percent of its use in edible products in 1989 and 1990.

Domestic use has risen over the past 3 years, although exports have dominated the demand for U.S. sunflowerseed oil (fig. 10; also see app. table 3). Domestic use is estimated at a record 135,000 metric tons in the 1991/92 marketing year, accounting for 37 percent of aggregate demand (USDA, *Oil Crops: Situation and Outlook Report*, July 1992, Table 31). The rise in domestic use is due in part to certain distinguishing physical characteristics, including a lighter color, bland flavor, and higher smoke point than soybean oil. Sunflowerseed oil is also lower in saturated fat (10.3 percent) than all other vegetable oils with the exception of canola (6.5 percent) and safflower (10.0 percent). In 1985, sunflowerseed oil high in monounsaturated fat was made available in commercial quantities that further improved stability and shelf-life potential (Carter, 1987).

Table 11--Sunflowerseed and oil exports, marketing years 1977-90

Marketing year	Exports				Export share	
	Seed	Oil	Seed equivalent[1] Oil	Seed equivalent[1] Total	Seed	Oil
	------- *1,000 metric tons* -------				*Percent*	
1977/78	942	34	85	1,027	92	8
1978/79	1,366	41	103	1,469	93	7
1979/80	1,820	86	215	2,035	89	11
1980/81	1,505	301	753	2,257	67	33
1981/82	1,555	103	258	1,813	86	14
1982/83	1,348	229	573	1,921	70	30
1983/84	1,044	188	470	1,514	69	31
1984/85	991	130	325	1,316	75	25
1985/86	365	205	513	877	42	58
1986/87	304	156	390	694	44	56
1987/88	270	319	798	1,067	25	75
1988/89	87	212	530	617	14	86
1989/90	96	159	397	493	19	81
1990/91	168	163	408	575	29	71

[1]Seed equivalent assumes oil content of 40 percent.
Source: Calculated from trade and production data, U.S. Department of Agriculture, Economic Research Service. *Oil Crops: Situation and Outlook Report.* Quarterly issues, 1977-92.

These physical attributes of sunflowerseed oil allow it to penetrate specialty markets that differentiate oils based on these characteristics. The demand for premium oils is more prevalent in consumer-visible oils markets, such as bottled cooking oils and margarine, or in the manufacture of products that call for fixed ingredient mixes either for taste or stability.

Export demand has traditionally dominated the oil-type sunflowerseed market, first as direct seed exports and later in the form of oil (table 11). In terms of seed-equivalent export demand, seed dominated U.S. exports throughout the 1970's and early 1980's, accounting for 67-93 percent of export sales. Seed exports have waned since 1984, due in part to oilseed policy changes in the EC and the aggressive marketing of oilseeds and meal by Argentine producers. As seed exports declined, U.S. crushing capacity expanded and, with the assistance of U.S. export policies (see Policy and Programs section), oil surpassed seed exports in 1985 and currently accounts for more than 80 percent of the seed equivalent exports.

Principal markets for U.S. sunflowerseed oil exports include the EC, Algeria, Mexico, Venezuela, Egypt, Canada, and Japan (See World Trade section). However, sunflowerseed oil exports remain far below levels achieved in the early 1980's.

Meal Market

The demand for and value of sunflowerseed meal is derived from its use as an animal feed. Demand is sensitive to size of the livestock herd, price of competing and complementary feeds, and the demand and resulting price for livestock. These markets are dynamic and fluctuate with movements in livestock markets and changes in the availability of competing feedstuffs. Demand for formulated feed has increased as livestock operations shifted from grazing to feed concentrates to meet the demands of a growing population (Ash, 1992).

Central Plains cattle feedlots and, to a lesser extent, North Central dairy operations are the principal consumers of sunflowerseed meal. In these markets, sunflowerseed meal competes with other high-protein feeds such as soybean, canola, and linseed meals. Sunflowerseed meal is generally discounted to other feed meals, partly because of its lower protein content. For example, sunflowerseed meal is generally sold at 28, 32, or 38 percent protein, compared with a 44 or 49 percent standard for soybeans. Higher fiber content and a limited availability of lysine (an important nutritional component in swine and poultry production) also limit demand. Retaining the hulls increases fiber content and meal volume but tends to lower overall energy value, which results in lower prices.

Export demand for sunflowerseed meal is limited. Most U.S. sunflowerseed meal is domestically consumed except for some limited trade with Canada. Domestic consumption accounted for 98 percent of annual disappearance between 1977 and 1990.

Confection Sunflowerseed

Confection sunflowerseed differs from oil-type sunflowerseed not only in its genetic characteristics, but also in the markets that drive seed demand. The larger seed size and loose hull of the confection sunflowerseed facilitates cracking and is well suited to the direct food uses market. Confection sunflowerseed has also made significant inroads into the breads and baked goods markets, both at home and abroad. In these markets, confection sunflowerseed competes with other nut crops such as peanuts, almonds, walnuts, cashews, and grains used in the production of multi-grain breads. Confections also compete for discretionary consumer income with other snack foods including potato and corn chips, dried fruits, cheese products, and candies.

Sunflowerseed's reputation among consumers as a healthful snack has fueled growth in demand although it has yet to gain the status (and associated market share) of other crops such as peanuts or potatoes. Sunflowerseed kernels provide approximately 4 grams of dietary fiber per ounce and 7 percent of the daily protein requirements for the

average adult male and are also a good source of thiamine and iron (Adams, 1975). These qualities have not been overlooked by consumers. Forty-five percent of those surveyed in a 1990 Gallup Poll commissioned by the National Sunflower Association indicated that sunflowerseed kernels were the most healthful nut compared with peanuts, almonds, walnuts, or cashews.

Specific studies on the mechanics of confection demand are limited. However, there are a number of conceptual relationships inherent to markets for specialty-use crops. Demand for sunflowerseed as a confectionery product is generally thought to be less price sensitive than for higher oil varieties. This price insensitivity results from a limited market size and the ability to differentiate the product from a limited set of substitutes. However, once this market is saturated, the quantity demanded becomes more sensitive to prices (elastic), falling to a price floor provided by oil and meal markets.

However, because confection sunflowerseed varieties have a lower oil content and higher hull-to-seed weight ratio than oil-type, these seeds are typically discounted to high oil varieties. For example, at 32 percent oil, confection seed is competitive at 70-80 percent of the oil variety price based on 40 percent oil content. Discounts can increase in years when oil-type seeds are abundant because of processing inefficiencies associated with increased hull-to-seed weight ratios.

Data pertaining to the demand for confection sunflowerseed are limited. USDA estimates place total demand for confection sunflowerseed (export and domestic uses including use for bird food and seed) in the 1990/91 marketing year at about 289,000 metric tons, up from an estimated 93,000 metric tons in 1985/86.

Domestic uses were the largest component of demand over the period but producers have increasingly made inroads into foreign markets and exports have responded accordingly. Most confection seed exported is dehulled, reflecting the comparative advantage of the dehulling technologies adopted by U.S. processors. The outlook for U.S. confection sales is optimistic because of an increasingly health-conscious market and an established processing capacity.

Bird-Food Market

Birds can thrive on sunflowerseed, as is evident from the common yield losses suffered from blackbirds. While this characteristic may tax producers in terms of annual yield losses, its value to the pet food industry has boosted demand for seed.

Data on the size and composition of the bird-food market and its importance to the U.S. sunflower industry are scarce. This data scarcity partly arises from the diverse nature of demand that ranges from local operations to national retailers.

Table 12--U.S. wildbird feed activity and expenditures, 1980 and 1985

Item	Unit	1980	1985	Percentage change
				Percent
Participants feeding	Thousands	62,463	82,508	32
Avg. months of feeding	Months	6.28	6	-4
Expenditures	Dollars	517,053	1,117,186	116
Spenders	Thousands	25,959	36,602	41
Avg. spending	Dollars	20	31	55

Source: U.S. Department of the Interior, Fish and Wildlife Service. *1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*. Nov. 1982, Tables 63 and 65, pp. 113-14.
U.S. Department of the Interior, Fish and Wildlife Service. *1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*. Nov. 1988, Tables 64 and 66, pp. 105 and 107.

Demand for bird food is primarily derived from its use in recreational activities such as backyard bird feeding and pet bird maintenance. A 1985 survey by the U.S. Fish and Wildlife Service found that over 82 million people participated in feeding wild birds, up 32 percent from 1980 (table 12) (U.S. Department of the Interior, 1988). While crumbs and table scraps represented the largest single component of the feed used in these activities, birdseed ranked second, with total sales in excess of $1 billion. This represents a doubling of 1980 expenditures, with the average participant spending $31 per year in 1985.

The direct impact of bird-food sales on the sunflowerseed industry is unclear. The National Sunflower Association estimated total sunflowerseed sales for bird food for the 1990/91 marketing year at roughly 200,000 tons, or 18 percent of reported 1990 production (National Sunflower Association, 1991). The impact on the market is further complicated by production totals in Pennsylvania, New York, and Georgia that are not included in national production and use figures. Both oil-type and confection varieties are used in bird-food mixes; however, oil types hold a preferred status in the market. This status and the associated price premium of oil types result from a thinner hull and higher energy-to-weight ratio.

Competition for sunflowerseed between crushers and bird-food manufacturers can lead to significant price spikes in late summer in years when stocks are in short supply. This competition resulted in bids exceeding $20 per hundredweight (cwt) in July and August 1990, leading some crushers to sell oil-type sunflowerseed stocks into the bird-food market. This market component of the industry could gain importance in the coming years as expenditures on seed for backyard feeding increase and new genetic varieties of sunflowerseed specifically targeted at the bird-food market are developed.

Sunflower Prices

Sunflower prices reflect interaction among global supplies and demand for sunflowerseed, oil, and meal. Weather, foreign trade, Government policy, and profitability relative to other crops or land uses influence prices. Prices also respond to the availability of production inputs, and the availability and price of other products that substitute for or complement the use of sunflowerseed products. Changes in these factors, whether anticipated or actual, can lead to wide swings in seed and product prices.

There is no single price for sunflowerseed or its products. Rather, prices are specific to individual markets for a specific timeframe. Smaller markets often derive their prices from larger trading centers based on transportation costs, relative quality, and the cost, time, and risk associated with moving the seed to a central processing location. Even in the major marketing centers for sunflowerseed, prices are overshadowed by movements in substitute markets such as the soybean complex that often serves as a benchmark for the U.S. oilseeds industry. Prices for sunflowerseed products and the prices farmers receive for sunflowerseed vary by season and year.

Seed Prices

The pricing mechanism for sunflowerseed is closely linked to the markets for vegetable oils and meal. The growing importance of non-oil uses that often compete with oil and meal processors for available seed supplies also affects the pricing mechanism. Disturbances in any of these markets that lead to different prices are invariably transmitted to the price of seed.

For seed destined for oilseed processing plants, the link between product values and seed prices is often presented in the following form:

$$P_s = [O\% * P_{oil}] + [M\% * P_{meal}] - P_p$$

where P_s indicates seed price, O% and M% indicate the extractable percentages of oil and meal in the seed, P_{oil} and P_{meal} represent the prices for the separate products, and P_p represents the margin required by processors to warrant crushing the seed.

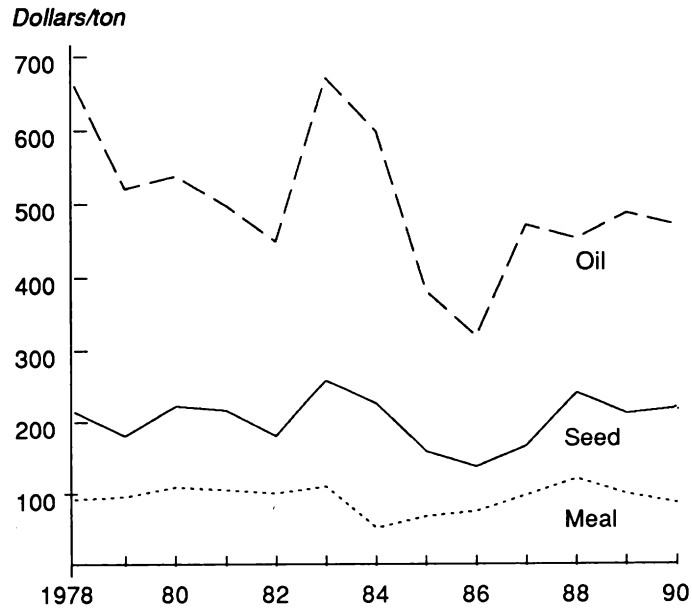
Oil Prices

Oil content for oil-type sunflowers typically exceeds 40 percent of the seed weight and, because of its higher price per pound, accounts for a larger share of the overall seed value. Sunflowerseed oil accounted for 74 to 89 percent of the seed value between 1978 and 1990 (table 10). Accordingly, fluctuations in sunflowerseed oil prices are likely to have a greater effect on seed prices than similar fluctuations in meal prices. As figure 11 illustrates, sunflowerseed prices generally move in unison with oil prices. In contrast, despite an increase in meal prices between 1984 and 1986, seed prices continued to decline.

Because of the high degree of substitutability among vegetable oils, markets for the individual oils have been shown to be closely linked to movements in other oil markets (Fryar and Hoskin, 1985). As a result, a small increase in the price of a given oil will lead to a significant decline in demand as consumers move to cheaper substitutes. Sunflowerseed oil prices consequently tend to move in unison with other edible oil prices (fig. 12).

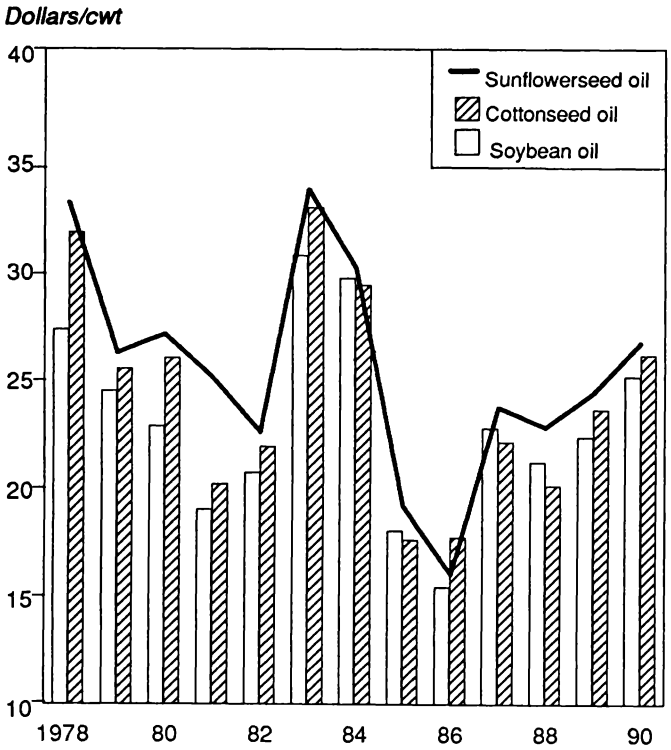
Because of the size of the U.S. soybean complex, combined with an active futures market, soybean oil tends to dominate the U.S. vegetable oil market and typically

Figure 11
Sunflowerseed and product prices, marketing years 1978-90



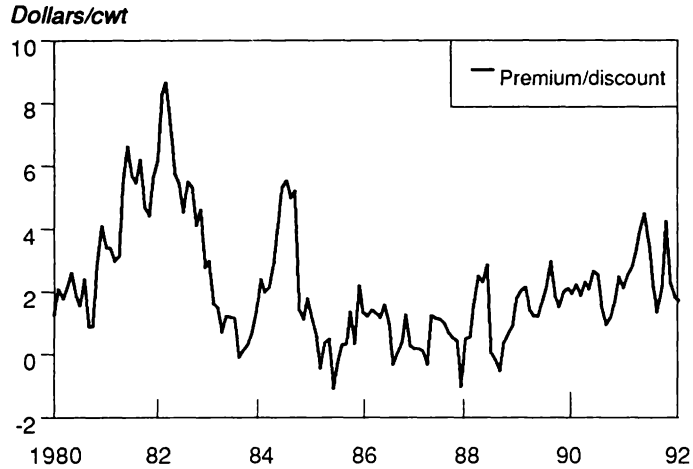
Source: Calculated from data in appendix tables 2, 3, and 4.

Figure 12
Relative vegetable oil prices, marketing years 1978-90



Source: Data from USDA, Economic Research Service. *Oil Crops: Situation and Outlook Yearbook.* July 1992, pp. 19, 27, and 32.

Figure 13
Sunflowerseed to soybean oil price premium, marketing years 1980-92



Source: Data from USDA, Economic Research Service. *Oil Crops: Situation and Outlook Yearbook.* July 1992, pp. 19 and 32.

serves as a benchmark price for sunflowerseed oil prices. Sunflowerseed oil prices tend to move parallel to soybean oil prices although sunflowerseed oil has certain distinguishing physical characteristics that often result in a price premium relative to soybean oil (fig. 13). Between 1979 and 1990, sunflowerseed oil carried an average of 1.5 cents per pound premium to soybean oil, increasing over the past few years, due in part to the effect of the Sunflowerseed Oil Assistance Program (SOAP).

Premiums and discounts (basis) among vegetable oils can contract or expand in response to changes in consumer tastes or the availability of that oil relative to close substitutes. The domestic demand for premium oils such as sunflowerseed oil is more prevalent in visible oils markets such as bottled cooking oils and margarine or in the manufacture of products that call for fixed ingredient mixes either for taste or stability. The premium status of such oils, however, can change rapidly in response to shifts in consumer preferences. For example, consumer interest in canola oil is growing because of its low saturated fat content and shifting away from palm oil, animal fats, and even soybean oil. The visible oil market, however, is relatively small, and premiums tend to dissipate as supplies build and producers are forced to compete directly in the bulk or price sensitive markets.

Meal Prices

Sunflowerseed meal prices are ultimately determined by the demand for livestock feeding and the price and availability of other feedstuffs that either complement or substitute for its use. In contrast to sunflowerseed oil, lower prices for meal limit its influence on seed prices. Meal represented only 20-25 percent of the overall seed value between 1978 and 1990.

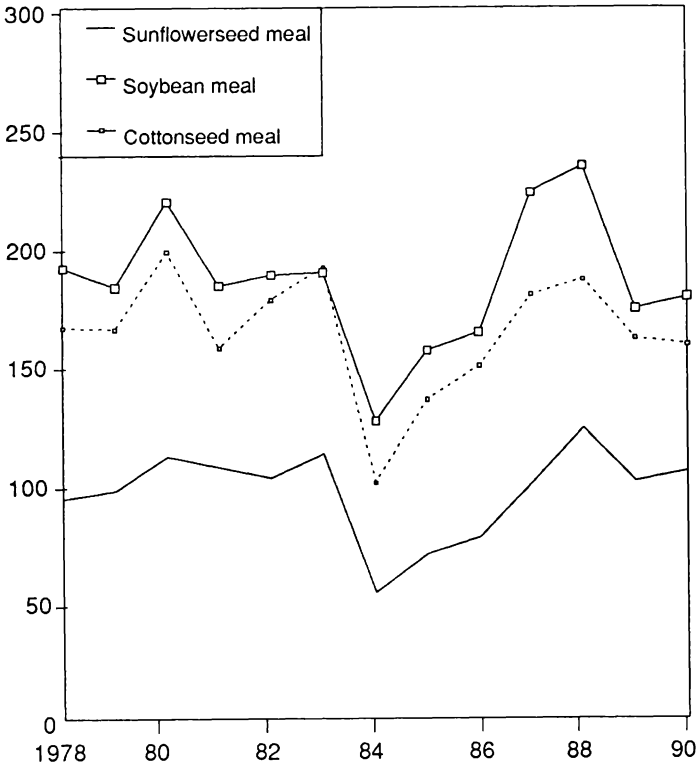
Soybean meal dominates the livestock feeds market together with the corn that serves as a feed complement. However, unlike the premium status given sunflowerseed oil, sunflowerseed meal is typically discounted to other higher protein meals (fig. 14). Prices are also structured according to protein composition and digestibility. While lower lysine content and higher fiber are not factors that limit the access of sunflowerseed meal to ruminant markets, they limit demand from swine and poultry producers. These factors reduce the value of sunflowerseed meal to the feed complex as a whole, pressuring prices when supplies of alternative feeds are abundant.

Confection Prices

The distinction between confection and oil-type sunflowerseed is important in terms of price movements. The availability of close substitutes for sunflowerseed meal and oil suggests that the demand for oil-type seed is likely to be

Figure 14
Relative oilseed meal prices, marketing years 1978-90

Dollars/ton



Source: Data from USDA, Economic Research Service. *Oil Crops: Situation and Outlook Yearbook.* July 1992, pp. 19, 27, and 32.

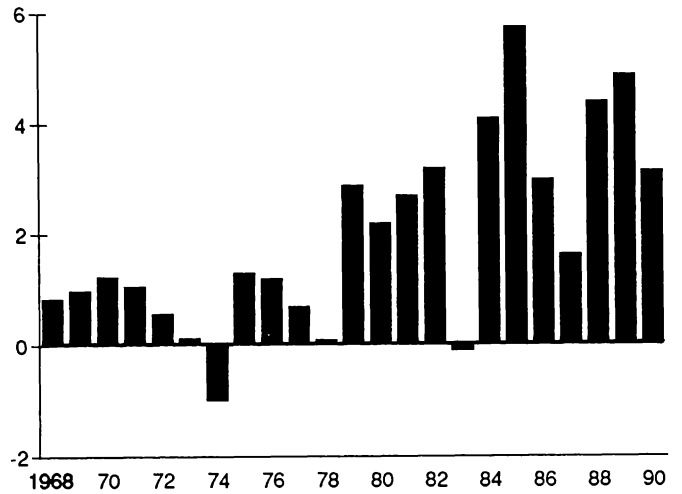
more price responsive (elastic) than the demand for seed for edible uses. As a result, an increase in production can lead to a larger decrease in price for confection than would result from a similar increase in the production of oil-type sunflowerseed. The price of confections does find support at lower prices as the seed makes its way into the crush and bird food markets, although typically at a significant discount to varieties with higher oil content.

Historical Price Trends

The interaction among the various markets and the forces that influence them can lead to dramatic price movements in seed prices. Prices for oil-type sunflowerseed followed a moderate upward trend during the late 1960's and early 1970's, trading in a narrow band between $4.00 and $5.50 per cwt. A move to a flexible exchange rate in 1972, followed by the weakening of the U.S. dollar in the world market, further increased the attractiveness of U.S. agricultural goods. Bolstered by worldwide shortages of high-protein feeds in a period when both demand and crushing capacity were increasing, sunflowerseed prices nearly doubled in 1973. Prices doubled again in 1974, as world supplies continued to tighten in the face of rapidly rising demand.

Figure 15
Confection sunflowerseed price premium, 1968-90

Dollars/cwt



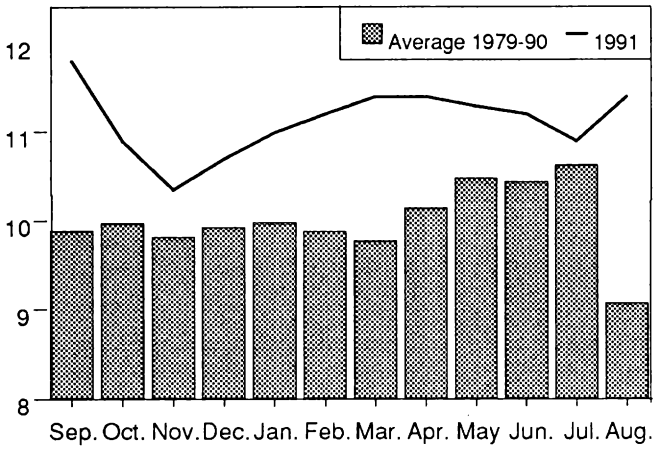
Source: Data from USDA, National Agricultural Statistics Service. *Crop Values.* Annual issues, 1970-92.

After peaking in 1974 at nearly $17 per cwt, sunflowerseed prices dipped sharply in 1975 and remained in the $10-$12 range through 1979. Changes in Federal farm policies, together with significant fluctuations in weather, led to more volatile prices throughout the 1980's. Season average prices during this period ranged from a high of $13 in 1983 to a low of $6.90 per cwt in 1986.

Prices for non-oil-type sunflowerseed generally carry a premium to oil-type seeds, due in part to the higher costs associated with seeding and managing the crop (fig. 15). Between 1968 and 1990, non-oil sunflowerseed carried an average $1.84 per cwt premium to oil-type seed. This premium expanded, averaging nearly $4 between 1988 and 1990, as prices for confection varieties grew at a pace faster than those for oil varieties, reflecting the growing market for non-oil uses.

Prices for both sunflowerseed varieties also vary throughout the season. Prices are generally lower in the fall when the majority of the crop is harvested. Prices tend to rise slightly through the rest of the year, compensating farmers for the cost of storing seed on the farm (fig. 16). Prices usually fall in August as storage bins are cleared to make room for the new crop. In contrast to this pattern, late season prices for oil-type sunflowerseed increased sharply in 1989 and 1990. This relationship reflected tight supplies for oil-type seed and growing competition for late season supplies between oilseed processors and bird-food packagers.

Figure 16
Seasonal sunflowerseed price patterns, selected marketing year averages
Dollars/cwt



Source: Data from USDA, National Agricultural Statistics Service. *Agricultural Prices.* Annual issues, 1980-92.

Price Discovery Mechanisms

The price volatility associated with changing market conditions adds to the uncertainty facing both sunflowerseed producers and processors. Prices that look attractive to producers in the spring can fall rapidly with a good harvest or as demand for seed, oil, or meal wanes. In contrast, poor harvests or shifts in cropping patterns can leave processors scrambling for limited supplies in the fall, bidding up prices. A number of pricing arrangements have evolved that offer producers and buyers alternative means to both establish prices and limit price risks. These include the use of cash forward contracts, cash bids, delayed payments, price options, and futures markets.

One of the most common pricing arrangements for producers of oil variety sunflowers is the cash forward contract. These contracts specify a quantity of seed to be delivered at a specific date for which the producer receives a guaranteed price. Contracts can be made for deliveries ranging from 1 week to more than 1 year forward. By contracting for future delivery, both the producer and buyer are assured a price, essentially eliminating any downside price risk for producers and upside price risk for buyers.

Shortfalls in production may force the producer into the cash market to buy the seed necessary to meet contractual obligations, often at a loss because the producer is obligated to deliver a specific quantity of seed. Even with adequate supply, should cash prices rise, producers are unable to capture any increase in prices. Producers commonly place less than expected production in forward contracts. However, buyers run the risk of paying higher contract prices in years when supplies surpass earlier expectations resulting in lower cash prices.

Producers can forgo downside price protection and accept the cash market price. The cash market offer, or cash bid, is a more traditional arrangement where a producer accepts the price offered by the local elevator, processors, or cooperative on the date the sunflowerseed is delivered. Payments from the buyer can be delayed, often until after January 1 for tax purposes, although the price will reflect cash bid on the day that the seed was delivered.

Deferred pricing terms add some flexibility to the cash bid system. Under this arrangement, sellers deliver the product and transfer title of ownership while delaying the date for selecting a settlement price. Deferred pricing allows farmers the opportunity to avoid storage costs while waiting for an upswing in market prices. Although this arrangement is less common in the sunflowerseed market, some processors have offered such contracts in the past when farmers were holding seed in expectation of higher prices in the near future.

The pricing arrangements available for confection sunflowerseed growers are often different than those available for oilseed producers and at present fewer options exist. The most commonly used pricing mechanism is the forward contract. However, unlike many oilseed contracts, confection contracts commonly specify the number of acres to be planted and the expected yield per acre as well as a price for the seed and any additional production. To reduce the risk of crop failure faced by producers, buyers often provide an "Act of God" clause that releases producers from their contractual obligations should the crop fail due to unforeseen circumstances.

Futures Market

A futures market existed for sunflowerseed on the floor of the Minneapolis Grain Exchange from May 6, 1980, to the last completed trade on March 3, 1982. For the short time that contracts were traded, the sunflowerseed futures market provided producers, elevators, processors, exporters, and foreign buyers with an alternative price discovery mechanism. However, as domestic production declined, market volume and liquidity deteriorated, leading to the eventual end of trading.

Although formal futures trading ended in 1982, the Duluth Paper Market infrequently provides an informal environment for participants to hedge their financial risks. In contrast to a futures contract, transactions were executed in regular cash contracts with varying delivery dates. Trade participation was generally comprised of exporters, domestic processors, commission houses, overseas buyers, and some country elevators, because of the size of a typical trading unit (1,000 metric tons). The Duluth Paper Market served as an implicit futures market, allowing buyers and sellers a certain degree of protection from supply and demand uncertainties as well as creating a market for trade

and production information. This informal pricing mechanism became less important as sunflowerseed exports declined and seed use shifted to domestic processors.

Cross-Hedging

Other futures contracts have been used as a proxy for sunflowerseed futures in the absence of formal futures markets or proxy markets like Duluth. This is commonly referred to as cross-hedging. Unlike hedging in a futures market for the same commodity, which implies the use of an equal and opposite position in a futures contract (holding cash sunflowerseed and selling a forward contract (short) in sunflower futures), cross-hedging involves the purchase or sale of a futures contract in a like commodity. For example, sunflowerseed has been cross-hedged against soybean oil futures, soybean meal futures, or a combination of soybean oil and meal futures. Cross-hedging can be effective when price movements for similar commodities are highly correlated. However, the system is imperfect at best and may perform poorly when traditional market relationships fail.

Cross-hedging can be a valuable tool for handlers, brokers, and processors. Commodity handlers often use hedging to preserve a predictable processing margin and to ensure a predictable cost of inventory carrying. Handlers use a "long hedge" in which they offset a cash purchase of a commodity with a sale of a futures contract in end products. The processor typically offsets the commodity purchase with the sale of a futures contract for vegetable oil and meal products.

In the following example, real data are used to illustrate the advantage of using a storage hedge to preserve a crush margin. In the example, summarized in table 13, sunflowerseed prices in Riverside, North Dakota, were $9.90 per cwt on Friday, October 5, 1990. Prices for 32 percent protein sunflowerseed meal were $110 per short ton in Fargo and sunflowerseed crude oil was $24 per cwt in Minneapolis. Assuming a 40 percent yield each of sunflowerseed meal (dehulled) and oil, the cash margin on that day is $1.90 per cwt. If the sunflowerseed is bought and stored, the products will be sold at a later date.

The processor, upon purchasing the seed, simultaneously sells soybean meal and oil contracts in the amount of oil and meal that is expected from processing the sunflowerseed. The Chicago Board of Trade's December soybean meal contract closed at $187.60 per short ton on Friday, October 5, 1990. The soybean oil contract closed at $22.57 per cwt on the same day. Assuming the processor sold contracts at the closing prices, and assuming 40 percent yields of oil and meal per ton of sunflowerseed, the value of the soybean products hedged would be $12.78 per cwt of sunflowerseed.

If on Friday, December 7, 1990, the processor lifts the hedge by purchasing soybean oil and meal contracts in amounts equal to those sold 2 months earlier, a gain of 68 cents per cwt is realized on the futures market transaction. The December soybean meal contract can be purchased for $174.60 per short ton and the oil contract can be purchased for $21.53 per cwt. Meanwhile, the prices of sunflowerseed meal and oil have declined to $100 per short ton and $23 per cwt, and the cash price for sunflowerseed has decreased to $9.55 per cwt.

Given the December prices for sunflowerseed and products and the $9.90 paid for the seed stored 2 months earlier, the cash crush margin has declined from $1.90 per cwt on October 5 to $1.65 per cwt on December 7. However, the $0.68 gain from settling the futures contracts more than offsets the $0.25 per cwt loss on the cash margin, leaving the previously hedged processor $0.43 per cwt more than an unhedged processor working on cash margin alone. The cash margin does not account for the cash market difference (basis) for sunflowerseed oil in Minneapolis and Riverside.

Marketing

Marketing can be described as the methods and strategies used to transfer goods or services from the producer to the consumer. The specific methods and strategies employed attempt to maximize the returns to production by delivering a quality product in a timely and cost-effective manner for the highest price available. Some of the elements important in developing an effective marketing strategy include pricing, transportation arrangements, and storage decisions.

Marketing strategies for sunflowerseed producers vary among regions and producers according to the location of production relative to transportation and processing facilities, as well as the pricing instruments available at those points. Due to differences in the dynamics of end-use markets themselves, strategies can differ by the variety and quality of sunflower produced.

Marketing Flows

Like many primary commodities, sunflowerseed passes through a number of intermediary stages before reaching the consumer. Throughout this process, the product takes on new and diverse forms. Figure 17 represents a simplified view of sunflowerseed marketing flows.

Seed is either transported directly or through intermediaries (elevators, cooperatives, brokers) to a central processor. The destination and use of local assembly points are

Table 13--Cross-hedging example

On Friday, October 5, 1990,

Cash margin assuming 40 percent yield of oil and meal per hundredweight of sunflowerseed:

Cash sunflowerseed meal, 32 percent protein, Fargo, ND, $110.00/ton = $5.50/cwt, x 0.40 =	Value =	2.20/cwt[1]
Cash sunflowerseed oil, Minneapolis, $24.00/cwt, x 0. 40 =	Value =	+ 9.60/cwt[1]
	Total product value =	11.80/cwt[1]
Cash sunflowerseed, Riverside, ND		- 9.90/cwt[1]
	Cash margin	$1.90/cwt[1]

The processor who purchased sunflowerseed at $9.90/cwt can reduce price risk by selling futures contracts for soybean meal and oil.

On October 5, 1990, soybean meal and oil contracts can be sold for:

Soybean meal (December contract), $187.60/ton = $9.38/cwt, x 0.40 =		3.75
Soybean oil (December contract), $22.57/cwt, x 0.40 =		+ 9.03
	Total value	$12.78/cwt[1]

By Friday, December 7, 1990,

The sunflower cash margin based on current prices is:

Cash sunflowerseed meal, 32 percent protein, Fargo, ND, $100.00/ton = $5.00/cwt, x 0.40 =	Value =	2.00/cwt[1]
Cash sunflowerseed oil, Minneapolis, $23.00/cwt, x 0.40 =	Value =	+ 9.20/cwt[1]
	Total product value =	11.20/cwt[1]
Cash sunflowerseed, Riverside, ND		- 9.55/cwt[1]
	Cash margin	$1.65/cwt[1]

The cash margin has declined $0.25/cwt.[1]

But now the hedger can "buy back" the futures contracts.

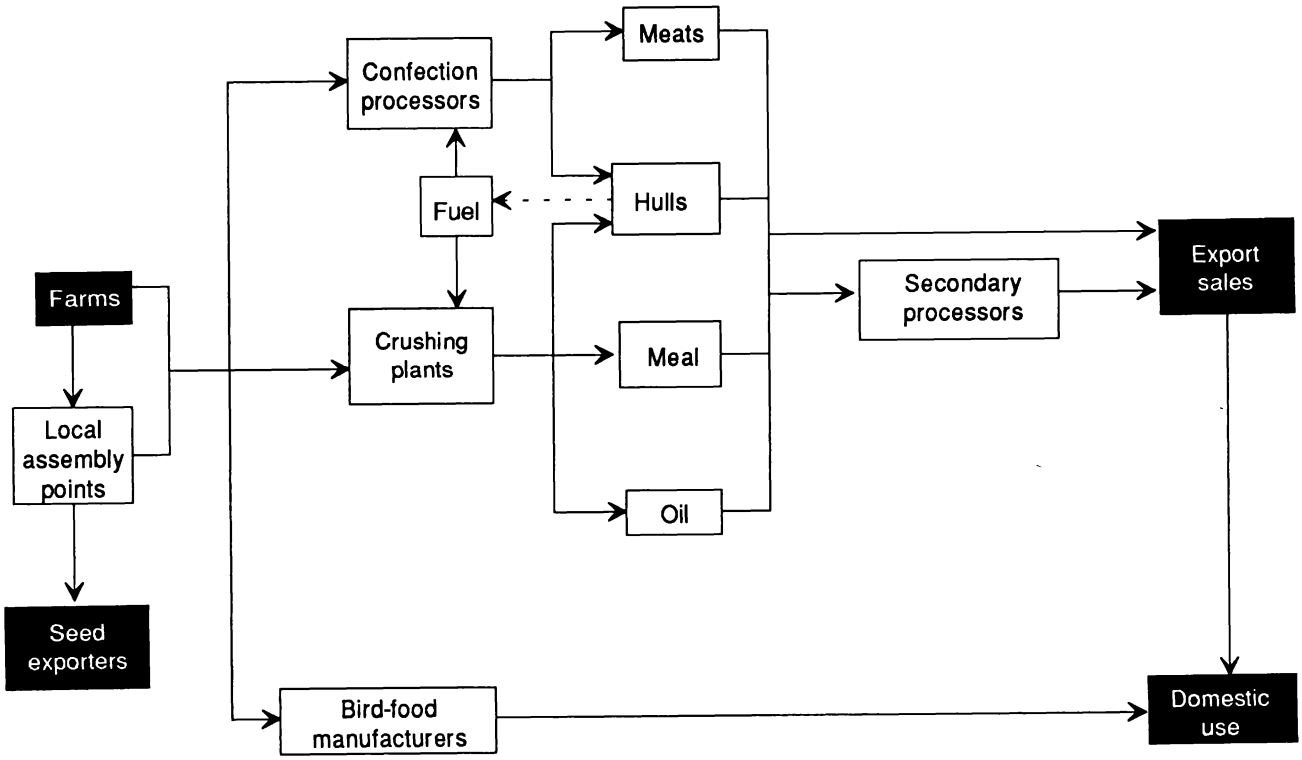
Soybean meal (December contract), $174.60/ton = $8.73/cwt, x 0.40 =		3.49
Soybean oil (December contract), $21.53/cwt, x 0.40 =		+ 8.61
	Total value	$12.10/cwt[1]

The futures contracts, which were sold for $12.78 to hedge 1 cwt of sunflowerseed, are bought back for $12.10, cancelling the obligation to deliver. The gain of $0.68/cwt[1] on the futures contracts more than offsets the $0.25/cwt[1] loss on the cash margin, leaving a net gain of $0.43/cwt.[1]

[1]Cwt of sunflowerseed.

Sources: Soybean, soybean meal, and soybean oil futures prices: *The Wall Street Journal*. "Commodity Futures Prices." Oct. 8 and Dec. 10, 1990. Sunflowerseed prices: *Ag Week*. "Sunflowerseed Prices," Vol. IV, Nos. 10 and 18, Oct. 8 and Dec. 10, 1990. Sunflowerseed oil prices: *Grain and Feed Market News*. "Sunflowerseed Oil Prices," Vol. 38, Nos. 41 and 50, Oct. 12 and Dec. 14, 1990. Sunflowerseed meal prices: The Miller Publishing Co. *Feedstuffs*, Vol. 62, Nos. 42 and 51, Oct. 8 and Dec. 10, 1990.

Figure 17
Marketing flow of U.S. sunflowerseed



Source: USDA, Economic Research Service.

Table 14--U.S. sunflowerseed crushing facilities and capacity

Plant/location	Capacity
	Tons/day
National Sun Industries Enderlin, ND	1,500
Archer-Daniels-Midland (ADM) Velva, ND	1,200
Cargill, Inc. West Fargo, ND	1,200
Archer-Daniels-Midland (ADM) Red Wing, MN	1,000
Agrigenetics/SVO Culbertson, MT	275

Source: National Sunflower Association. *1990 U.S. Sunflower Crop Quality Report*. Bismark, ND, 1991, p. 19.

largely determined by the type of seed grown and the location of that production relative to processing points.

Oil-type sunflowerseed is typically shipped to crushing plants located in eastern North Dakota and Minnesota where the seed is crushed to produce sunflowerseed oil, meal, and hulls. Hulls are commonly used as a fuel to generate electricity for the plants, but they can also be mixed back into the meal or mixed with other feedstuffs. Oil for domestic use is then refined before reaching the consumer in the form of salad and cooking oils, margarine, processed foods, and baked goods. Both crude and refined oils are also exported, reaching foreign consumers in similar forms.

Major processing centers for oil-type sunflowerseed include Enderlin, Velva, and Fargo, North Dakota, and Red Wing, Minnesota (table 14). Plants with smaller sunflowerseed-processing capacities are also located in Montana, Texas, and Oklahoma. Processing centers for confection sunflowerseed are located in the Red River Valley in North Dakota and Minnesota and along the Colorado and Kansas border. A number of smaller facilities are scattered across the country.

Sunflowerseed meal is used primarily as an ingredient in feed manufacturing. Much of this feed currently moves to cattle feedlots throughout the Central Plains. A smaller portion of meal production finds a niche in Northern Plains and Lake States dairy operations. Through feeding, sunflowerseed is transferred to consumers through beef and dairy products, purchased further down the marketing channel.

Oil-type sunflowerseed is a preferred ingredient in many bird-food mixes because of the thinner hulls and higher energy-to-weight ratio. Seed moves directly past oil and meal processors to operations across the country that mix and bag seed. Oil-type seed is not generally used in confection products.

Non-oil sunflowerseed is primarily targeted to confection processors, where their larger meat sizes facilitate their use in products such as candies, baked goods, or as a roasted product. Confection sunflowerseed can find a secondary market in bird-food mixes or for crushing, but generally at a significant price discount due to higher hull weight and lower oil content.

Transportation

The method and resulting cost of transporting sunflowerseed to the market has a direct effect on producers' returns. Depending on location, size of shipment, destination, and relative costs, sunflowerseed can be transported via truck, rail, or barge. Transportation patterns have shifted over the past 20 years as the size of the sunflowerseed crop has changed and as new markets have evolved.

Seed exports dominated the demand for domestic sunflowerseed production throughout the late 1970's and early 1980's, accounting for more than 70 percent of all seed sales (fig. 18). Rail initially dominated the transportation markets, because of the longer distances associated with delivering the seed to export ports along Lake Superior and the barge terminals in Minneapolis.

Trucks became the preferred mode of transportation between 1976 and 1989, due in part to more flexible rates and the ability to quickly respond to changing market conditions (table 15). In 1976, for example, rail accounted for 64 percent of all sunflowerseed shipments to Duluth/Lake Superior and 81 percent of shipments to Minneapolis. By 1980, rail accounted for less than 30 percent of the shipments to both destinations, with trucks accounting for 71 percent of the shipments to Duluth/Lake Superior and 77 percent of the shipments to Minneapolis (Olson and Zink, 1990).

Railroads regained their market share in the early 1980's by offering more competitive rates and adding flexible shipping arrangements such as three-car and multiple-origin trains. This flexibility attracted some of the smaller merchandisers and producers who had previously relied on trucks, as well as merchandisers entering the growing Mexican seed export market.

U.S. exports fell and a larger portion of the crop was absorbed at home, as sunflowerseed and other oilseed production increased in Europe and Argentina. Accordingly, the distance to markets declined and trucking regained the principal share of the transportation market. The shift away from rail was further fueled by rising rail rates, reduced rail coverage, and declining fuel prices.

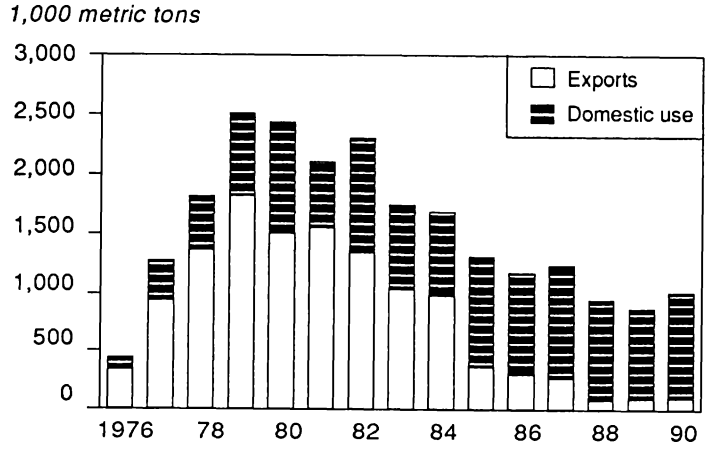
Storage

Storage allows producers and processors to smooth out the seasonality in sunflowerseed production to meet market demands throughout the year and to make the best use of processing capacity. Seed can be stored at various points between the farm and final destination, whether it's an export market or domestic processing plant.

The low density of sunflowerseed facilitates the use of structures set up to handle other small grains. Seed can be stored for more than one season under proper conditions, although confection processors prefer not to use seed that has been stored more than a season. Seed is generally stored at 8- to 10-percent moisture content and at temperatures preferably below 40° F (5° C) to reduce the risk of mold and insect damage (McMullen, 1985).

Storing sunflowerseed, either onfarm or at local assembly points such as country elevators or cooperatives, allows producers to delay the transfer of ownership. The decision to store onfarm is influenced by storage capacity, storage

Figure 18
Composition of sunflowerseed demand, marketing years 1976-90



Note: Domestic use includes seed for crush, non-oil use, and seed.
Source: Data from USDA, Economic Research Service. *Oil Crops: Situation and Outlook Yearbook*. July 1992, p. 31.

Table 15--North Dakota sunflowerseed shipments, by method and destination, 1976-89

Year beginning September 1	Shipments		Destination			Total shipments
	Rail	Truck	Minneapolis -St.Paul	Duluth-Superior	Misc. markets	
	Percent					1,000 mt
1976	55	45	6	56	39	227
1977	36	64	6	74	20	744
1978	27	73	6	80	14	1,150
1979	28	72	6	72	21	1,393
1980	40	60	9	59	33	1,677
1981	59	41	6	63	31	1,618
1982	66	34	12	53	35	1,767
1983	64	36	11	39	49	1,502
1984	63	37	7	55	37	1,124
1985	42	58	7	24	70	777
1986	31	69	5	16	79	886
1987	48	52	6	12	82	921
1988	32	68	6	0	93	567
1989	26	74	7	1	92	467

Source: Barry M. Olson and Daniel L. Zink. *North Dakota Grain and Oilseed Transportation Statistics*. UGPTI Pub. No. 83. Upper Great Plains Transportation Institute, Fargo, ND, Dec. 1990, various tables.

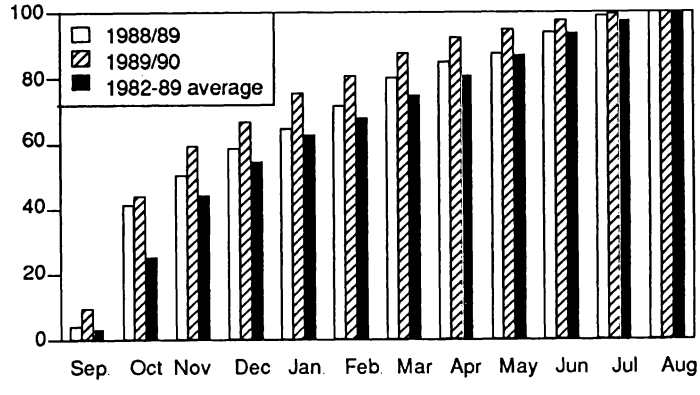
Table 16--Sunflowerseed storage patterns, 1983-91

Date	On farms	Off farms	All positions	On farms	Off farms
	Million pounds			Percent	
10/1/83	153	267	419	36	64
10/1/84	8	63	71	11	89
10/1/85	86	70	156	55	45
09/1/86	315	153	468	67	33
09/1/87	340	218	558	61	39
09/1/88	170	265	435	39	61
09/1/89	77	97	174	44	56
09/1/90	8	48	56	14	86
09/1/91	33	155	188	18	82
Average	N/A	N/A	N/A	38	62

N/A = Not applicable.
Source: U.S. Department of Agriculture, National Agricultural Statistics Service. *Grain Stocks*. Various issues, 1983-92.

Figure 19
Sunflowerseed: Cumulative monthly sales, selected marketing year averages

Percent of total sales



Source: Data from USDA, National Agricultural Statistics Service. *Crop Production*. Dec. issues, 1984-91.

costs, the risk of damage from pests, shrinkage, or spoilage, and anticipated price movements. The amount of seed stored onfarm declines throughout the season, with bins generally clearing before the next harvest. For example, in January 1985, sunflowerseed stored on farms totaled about 1 billion pounds. By May, onfarm stocks were down to 700 million pounds and down to 400 million pounds a month later. By the end of September, 1985 crop stocks had declined to 86 million pounds (table 16).

Off-farm storage includes commercial storage at local and terminal elevators, and storage facilities at processing plants. Storage fees vary according to lot size and local bin space availability. Commercial rates are typically higher than onfarm storage costs (Schaub and others, 1988).

Monthly Marketing

Sunflowerseed producers with onfarm storage facilities or with access to local storage space can market their seed throughout the year, creating opportunities to benefit from price movements. In practice, however, more than 50 percent of farm sales occur during the first 4 months of the marketing year and roughly 90 percent of the crop is sold prior to planting the succeeding year's crop (fig. 19). October was the most active sales month between 1982 and 1991, indicating that a large share of the crop is sold at harvest. Early season marketings have increased, possibly due to increased reliance on forward contracting of seed and cash-flow considerations.

Seed Quality

The price a farmer receives, whether forward contracted or cash sales, will depend on the quality of the seed. This includes the amount of foreign material in the seed, seed size, weight, and oil content. There are two official U.S. sunflowerseed grades based on the amount of damaged and dehulled seed: Grade 1 and Grade 2. Grade determinations are made on the basis of the seed when free from foreign material. Grading at purchasing points considers other factors such as oil characteristics and seed size (for confections). Upon delivery, elevators or processors sample the seed to establish the quality of that lot relative to the industry standard. Once the quality is established, producers may receive a premium or discount.

Premiums are typically tied to oil content for oil-type sunflowerseed, often offering a percentage increase in price for each additional percent increase in oil content above 40 percent. An example of this arrangement is the 2-to-1 oil premium. Under this arrangement, a producer receives a 2-percent increase in price for each percent of oil content above 40 percent. Other premiums may be offered for genetic varieties or for oil quality. Premiums are offered in select locations for sunflower varieties high in monounsaturated fat.

Policy and Programs

Agricultural policy has played an important role in shaping the patterns of domestic agricultural production and foreign trade. Despite limited direct involvement with domestic sunflower production, other programs such as agricultural export programs, tariffs, and policies that affect competing crops have had an impact on the industry. The 1990 farm act made significant changes in farm programs, many with direct implications for the sunflowerseed industry, including new market-oriented commodity program provisions and new price supports for oilseeds.

Agricultural Export Programs

Agricultural export programs have been an important component of U.S. agricultural policy since the 1920's. Since that time, programs have taken various forms in an effort to achieve a wide array of public policy objectives. These objectives include domestic supply control, maintenance and development of foreign markets, humanitarian measures, and foreign policy objectives.

Export programs that directly affect the sunflowerseed industry include:

- Export Credit Guarantee Program (GSM/102/103)
- Food for Peace Program (PL-480)
- Export Enhancement Program (EEP)
- Sunflowerseed Oil Assistance Program (SOAP)

GSM

GSM programs are designed to facilitate agricultural exports to countries unable to import goods without credit. Credit guarantees increase the availability of commercial credit by transferring the risk of nonpayment from the private to the public sector. This transference of risk often lowers interest rates, stimulating export demand. Earlier programs, such as the GSM-5, provided direct Federal credit for the purchase of surplus commodities in Commodity Credit Corporation (CCC) inventories.

Credit is allocated to a country on a commodity-by-commodity basis and is targeted to countries that offer strong potential for long-term market development for U.S. agricultural products. Potential borrowers are also characterized by their ability to repay their loans. In recent years, Latin America, the Middle East, and North Africa have been the principal destinations of U.S. oilseed exports under the GSM program (McKinnell and Suarez, 1990). Eastern Europe and the former Soviet Union have begun to benefit from these programs.

Although credit guarantees have historically been dominated by grain crops, oilseeds and oilseed product exports

Table 17--Sunflowerseed and oil export assistance programs, sales summary, marketing years 1979-90

Marketing year	Sunflowerseed oil				Seed
	PL-480	GSM	EEP	SOAP	GSM
	1,000 metric tons				
1979/80	0	0	0	0	0
1980/81	0	0	0	0	49
1981/82	0	0	0	0	133
1982/83	0	910	0	0	608
1983/84	9	8	0	0	65
1984/85	0	1	0	0	9
1985/86	6	159	0	0	250
1986/87	9	83	0	0	195
1987/88	4	125	133	0	204
1988/89	0	133	53	54	10
1989/90	0	67	8	27	0
1990/91	N/A	50	0	51	0

N/A = Not available.
Source: U.S. Department of Agriculture, Foreign Agricultural Service. *World Oilseed Situation and Outlook*. Various issues, 1979-91.

also benefited from credit programs. Both short-term credit (up to 3 years, GSM-102) and longer term credit (3-10 years, GSM-103) have been used to facilitate exports of sunflowerseed oil and seed (table 17). GSM sales have facilitated as much as 75 percent of sunflowerseed oil export sales and as much as 67 percent of seed export sales between 1978 and 1990.

PL-480

The Food for Peace program (PL-480) originated shortly after World War II as a means to achieve various foreign policy and humanitarian objectives. The 1990 farm act reauthorizes Title I government-to-government concessional sales, with maximum repayment terms of 30 years. Discretionary repayment, in local currencies, can be used to support market development, agricultural development, and research, and to pay U.S. Government obligations. Title II emergency and private assistance donations were also reauthorized by the 1990 Act. A new Title III Food for Development program is authorized that provides government-to-government grant food assistance to lesser developed countries. Local sales proceeds can be used to support a variety of economic development and related activities in recipient countries.

Exports of sunflowerseed oil have been limited under the PL-480 program, accounting for less than 5 percent of annual exports. There have been no PL-480 sales of sunflowerseed oil since 1987/88.

EEP

The EEP, established by the Food Security Act of 1985, provides export assistance in the form of cash bonuses that enable U.S. farmers to meet competition from subsidizing countries, particularly the EC. Major objectives of the program are to challenge unfair trade practices, expand U.S. agricultural exports, and encourage other exporting countries to negotiate on trade issues. An announcement of an EEP initiative is a multi-step process that begins with development of a proposal within the U.S. Department of Agriculture (USDA). USDA follows four guidelines to select commodities and countries that will best meet EEP's trade policy objectives:

- Countering competitors' unfair subsidies and trade practices in targeted markets,
- Possessing the potential to develop, expand, or maintain markets for U.S. commodities,
- Minimizing the impact on nonsubsidized competitors, and
- Maintaining the minimum level necessary to achieve the program's expected benefits of export expansion and trade policy reform (Collins and Salathe, 1990).

Once an EEP initiative is announced, private exporters contact prospective buyers or buyers tender for the initiative and accept offers from exporters. After agreement on the sale, the exporters submit a request for a subsidy to complete the sale. The sale may be contingent upon USDA's approval of a bonus. A bonus is paid to the exporter in cash if approved. The bonus system compensates the exporters for reduced sales prices, increasing the competitiveness of U.S. products.

Wheat and wheat flour sales have dominated EEP expenditures from the program's inception, accounting for 85 percent of EEP sales between 1985 and 1989 (Ackerman and Smith, 1990). EEP sales of vegetable oils, including sunflowerseed oil, started in 1987. Sales of sunflowerseed oil ranged from 133,400 metric tons in 1987/88 to 8,000 metric tons in 1989/90. EEP-assisted sales have had a significant effect on sunflowerseed oil sales, accounting for more than 40 percent of sunflowerseed oil export sales in 1987/88. EEP sales, as with other export program sales, can benefit producers in cases where additional exports of oil increase the demand for domestic seed, resulting in higher domestic seed prices.

SOAP

SOAP is specifically designed to help U.S. exporters meet prevailing world prices for sunflowerseed oil in targeted markets. Like EEP sales, U.S. exporters arrange sunflowerseed oil sales with buyers in targeted countries and request a bonus from USDA. Until fiscal year 1992, SOAP bonuses were paid to the exporter in sunflowerseed oil. Bonuses are now paid in cash, as in the EEP. These bonuses help exporters to meet competitor's prices on the world market.

SOAP bonuses were used only in Egypt (55 percent of sales) and Algeria (45 percent) through December 1990. Bonuses ranged between 369 and 730 pounds per metric ton sold through December 1990, resulting in an effective rebate of roughly 17-33 percent. Targeting was expanded in May 1991 to include Mexico, and in November 1991 to include Turkey, the former Soviet Union, and Venezuela. Funding available for fiscal year 1992 totals $50 million for use as SOAP bonuses and a similar bonus program for cottonseed oil.

Import Tariffs

Import tariffs or duties are taxes imposed on imported commodities. These taxes can be levied on an ad valorem (percentage of value), unit, or mixed basis. Tariffs were originally used as a source of Federal revenue. Tariffs can also be targeted to counter aggressive export policies of competitors or in retaliation against restrictive import barriers. These policies protect domestic industries, such as agriculture, by increasing the price paid for imported goods and shaping terms of international trade, often at the expense of consumers and market efficiency.

While no tariffs are levied on imported sunflowerseed, the domestic sunflower industry benefits from tariffs levied on sunflowerseed meal and oil imports. For example, the tariff on sunflowerseed meal was a unit tax of $7 per metric ton in 1992 (table 18). The tariff for imported sunflowerseed oil was a unit tax of $20 per metric ton plus an ad valorem tax of 4 percent of the imported value. Lower tariffs apply to sunflower products imported from Canada because of the U.S.-Canada Free Trade Agreement. Increasing the price of imports raises the demand for domestically produced products, partially protecting domestic processors from foreign competition.

The domestic sunflower industry also benefits from tariffs levied on products that serve as substitutes in domestic markets. These taxes include tariffs on other feedstuffs such as rapeseed meal or linseed meal that compete with sunflowerseed meal in the north-central cattle and dairy markets as well as tariffs on imported vegetable oils such as safflower, canola, or soybean oil.

Table 18--General tariffs for U.S. imports of selected oilseeds and oilseed products, 1992

Crop	Product	General tariff[1]
		$/metric ton
Sunflowers	Seed	Duty-free
	Oil	20 + 4%
	Meal	7
Soybeans	Seed	Duty-free
	Oil	22.5%
	Meal	7
Canola	Seed	9
	Oil	75
	Meal	2.6
Safflower	Oil	20 + 4%
Cottonseed	Oil	66
	Meal	7
Flaxseed (linseed)	Seed	8.6
	Oil	99
	Meal	2.6
Peanuts	Seed[2]	93.5
	Oil	88
	Meal	7
Palm	Oil	Duty-free
Coconut	Oil	Duty-free
	Meal	7
Palm kernel	Oil	Duty-free
	Meal	7

[1]The U.S.-Canada Free Trade Agreement lowers tariffs on imports from Canada. [2]In-shell basis.

Source: U.S. International Trade Commission. *Harmonized Tariff Schedule of the United States (1992).* USITC Pub. 2449. U.S. Government Printing Office, Washington, DC, Nov. 1, 1991. Seed: Section II, chapter 12, p. 2. Oil: Section III, chapter 15, pp. 3-5. Meal: Section IV, chapter 23, p. 2.

The effects of end-product tariffs on the domestic market can be uneven. Restricting imports of meal and oil bolsters domestic prices. Higher prices for end products encourage domestic processing, increasing demand for seed. Because domestic sunflowerseed prices are also influenced by the price of imported sunflowerseed, which is tariff free, the effect of end-product tariffs on domestic seed prices is uncertain.

For example, increased domestic demand for seed can lead to higher seed prices in situations where domestic producers are more efficient than competitors or in cases where transportation costs or shortfalls in foreign production limit availability. If cheaper seed is available, domestic producers benefit only from the differential in transportation costs.

Policies That Indirectly Affect the Sunflower Market

One of the principal objectives of domestic farm policy since the early 1930's has been the support and stability of farm income. To achieve this objective, policy has often relied on combinations of commodity price supports and supply controls. There were no domestic policies specifically targeted to sunflowerseed production prior to the 1990 farm act. However, support for other crops has played an important role in determining the attractiveness of those crops that compete with sunflowers for cropland and farm resources.

The decline in sunflower acreage throughout the 1980's is often associated with changes in commodity program structure that linked benefits to the production of a select set of crops (excluding most oilseeds). Income supports were determined on the basis of a producer's planting history (base) and yield history under the provisions established by the 1981 farm act and modified by the Food Security Act of 1985. Although yield histories were frozen in 1985, base acreage continues to be calculated as a 5-year moving average of acres planted and considered planted. Planted acreage includes acreage idled in annual commodity programs and acreage that was prevented from being planted because of factors such as drought or flood.

Participating farmers were generally required to plant the crop to which the base applied or divert those acres to a conserving use to guarantee annual benefits and to maintain eligibility for benefits after 1985. Failure to comply with this provision resulted in the forfeiture of support payments and a reduction in base acreage.

The crop-specific nature of these provisions linked annual support payments to a limited set of cropping choices, raising the returns from program crop production relative to nonprogram crops. Higher and more stable returns tended to encourage farmers to maximize production of supported crops. In the case of sunflowers, high support prices for crops such as wheat and barley have been shown to have had a negative effect on the number of acres planted to sunflowers (McCormick and Hyberg, 1991).

The 1990 Farm Acts

The Food, Agriculture, Conservation, and Trade Act of 1990 and the Omnibus Budget Reconciliation Act of 1990 significantly changed farm programs. The main goals of these 1990 acts were to reduce the Federal deficit, improve the competitiveness of U.S. agriculture, and enhance the environment. The acts amended several existing provisions to achieve these objectives while adding a number of new programs specific to oilseeds.

A number of these changes have direct implications for the sunflower industry. New provisions allow farmers the flexibility to plant alternative crops, including sunflowers, on 15 percent of their crop acreage base without directly affecting program payments or base acreage histories. Modifications in "0-92" provisions allow program participants the option to plant minor oilseeds (sunflowers, flaxseed, safflower, canola, rapeseed, and mustardseed) on up to 100 percent of their permitted wheat and feed grain acreage while maintaining up to 92 percent of their deficiency payments. Sunflowerseed producers may also be eligible for direct price supports in the form of a marketing loan. These changes may increase the attractiveness of sunflowers relative to traditional program crops such as wheat and barley.

Planting Flexibility

The concept of planting flexibility addresses concerns that the rigidity of crop-specific income support programs favor the production of supported crops, limiting farmer responsiveness to market signals. These income support programs limited the sector's ability to react to changing market conditions by distorting market signals. Rigid program rules became a logical scapegoat for limiting U.S. oilseed acreage because oilseeds were not supported as other program crops (wheat, corn, sorghum, barley, oats, cotton, and rice). This situation was aggravated by production and export subsidies for oilseeds and oilseed products in the EC and South America.

Partly in response to this situation, the 1990 farm legislation authorizes producers to harvest previously ineligible crops (including oilseeds) on up to 25 percent of their enrolled program acreage while protecting crop acreage histories. The maintenance of crop acreage histories, commonly referred to as base, is important to farmers because it determines eligibility for price supports and deficiency payments for program crops. In an effort to reduce budget outlays (an important theme in 1990 legislation), the flexibility provisions were further modified to eliminate deficiency payments on 15 percent of base (normal flexible acres (NFA)), regardless of whether the program crop or another crop was planted on such acres. If a producer elects to plant another crop on an additional 1 to 10 percent of the base (optional flexible acres (OFA)), deficiency payments would be eliminated on that percent of the base.

Producers of minor oilseeds were granted additional options through modifications of the 0-92 provisions. Under previous law, planting alternative crops on program acreage resulted in a loss of program benefits and base.

Figure 20

Wheat program participation under the 1985 farm act

Program payments	Acreage description	Management options	Notes
No deficiency payments	ARP: 15 acres	Idle	Acreage Reduction Program acres (ARP) must be idled to meet participation requirements. (15 percent for wheat in 1991.)
Eligible for wheat deficiency payments if planted to wheat or put into a conserving use under the 0-92 program.	Wheat for payment: 85 acres	Plant to wheat or dedicate to a conserving use.	

Source: Ian McCormick. "Minor Oilseeds and the 1990 Farm Bill: Rules, Regulations, and Initial Impacts," *Oil Crops: Situation and Outlook Yearbook*. OCS-30. U.S. Dept. Agr., Econ. Res. Serv., July 1991, p. 17.

Under the 10-25 and later 0-25 options first established for the 1989 crop, farmers could plant soybeans and sunflowers on up to 25 percent of their permitted acres without losing base. However, to do so meant forgoing deficiency payments on acres shifted to an alternative crop. For example, under the 1985 provisions, a producer with 100 acres of wheat base (fig. 20), after meeting the set-aside requirements for wheat (15 percent in 1991) to assure deficiency payment eligibility, could plant 85 acres of wheat or dedicate the 85 acres to a conserving use. Planting a crop other than wheat on this acreage resulted in an acre-for-acre loss of deficiency payments and a reduction in base starting the following year.

Farmers can plant up to 25 percent of their base to an alternative crop without losing base under the new flexibility provisions (fig. 21). Also, because 15 percent of the base (NFA) is no longer eligible for deficiency payments, planting an alternative crop on that 15 percent will not directly affect program benefit levels. To plant an alternative crop on the remaining 10 percent of the acreage (OFA), the producer will have to give up deficiency payments on each acre planted to the nonbase crop.

In the case of sunflowers, farmers can plant up to 100 percent of their permitted wheat and feed grain bases to sunflowers and maintain up to 92 percent of their deficiency payments (fig. 22). However, under the 1990 farm act, farmers are not eligible to plant minor oilseeds on rice or cotton base under the 50-92 program. Producers could shift to a rotation that included sunflowers while maintaining 92 percent of their wheat deficiency payments. Alternatively, producers may receive price support benefits for the sunflowers, planted on wheat and feed grain bases, by forgoing deficiency payments. The decision to shift to sunflowers under the new provisions depends on the expected market returns for the competing crops, experience and capital required to establish the crop, as well as the relative yield and price risks. However, under the 1990 farm act, farmers are not eligible to plant minor oilseeds on rice or cotton base under the 50-92 program.

Oilseed Marketing Loans

The 1990 farm act also requires that the Secretary of Agriculture make nonrecourse marketing loans for soybeans, sunflowerseed, canola, rapeseed, safflower, flaxseed, and mustardseed available to producers. The purpose of the marketing loan program is to provide income support and cash flow for producers while maintaining competitiveness by keeping the seed in the marketing channel. A marketing loan does not extend the price floor to world production as would a traditional nonrecourse loan.

Figure 21

Wheat program participation under the 1990 farm act, using planting flexibility

Program payments	Acreage description	Management options	Notes
No deficiency payments	ARP: 15 acres	Idle	Normal Flexible Acres (NFA) can be planted to any crop, including oilseeds, except fruits and vegetables. (15 percent for wheat in 1991.)
No deficiency payments	NFA: 15 acres	Plant to any crop except vegetables or fruits.	
	OFA: 0-10 acres		Optional Flexible Acres (OFA) have the same crop options as NFA, but the producer must forgo deficiency payments to plant other crops.
Eligible if planted to wheat.	Wheat for payment: 60-70 acres	Plant to wheat.	

Source: Ian McCormick. "Minor Oilseeds and the 1990 Farm Bill: Rules, Regulations, and Initial Impacts," *Oil Crops: Situation and Outlook Yearbook.* OCS-30. U.S. Dept. Agr., Econ. Res. Serv., July 1991, p. 18.

Figure 22

Wheat program participation under the 1990 farm act, using Normal Flexible Acres and the 0-92 option

Program payments	Acreage description	Management options	Notes
No deficiency payments	ARP: 15 acres	Idle	Conserving Use acres (CU) are idled from a program crop and maintained in an approved conserving use or planted to a minor oilseed.
No deficiency payments	NFA: 15 acres	Plant to any crop except fruits or vegetables.	
Eligible if planted to a minor oilseed or placed in a conserving use.[1]	No payment CU: 5.6 acres	Plant to a minor oilseed or an approved conserving use.	
	0-92 option CU or minor oilseed acreage: 64.4 acres		

[1]Farmers who opt for the deficiency payments are ineligible for the marketing loan.

Source: Ian McCormick. "Minor Oilseeds and the 1990 Farm Bill: Rules, Regulations, and Initial Impacts," *Oil Crops: Situation and Outlook Yearbook.* OCS-30. U.S. Dept. Agr., Econ. Res. Serv., July 1991, p. 18.

National average loan rates for 1991-95 soybean crops will be at least $5.02 per bushel and $0.089 per pound for the minor oilseeds (sunflowers, flaxseed, canola, rapeseed, safflower, and mustard). The Omnibus Budget Reconciliation Act of 1990 requires producers who receive an oilseed loan or loan deficiency payment to pay a 2-percent loan origination fee to help offset the cost of the oilseed program. The effective loan rate refers to the national average loan rate minus the 2-percent loan origination fee. It does not account for adjustments associated with interest due on capital or adjustment due to location.

Farmers will be eligible to repay loans at the lesser of the loan rate or the prevailing world-market price, as determined by a formula prescribed by the Secretary of Agriculture, under the marketing loan provisions. Alternatively, producers may be allowed to repay loans at a level that minimizes potential loan forfeitures, Government stocks, and storage costs, and allows U.S. oilseeds to be freely and competitively marketed.

For example, if the market price for sunflowerseed should drop below the national average loan rate of $0.089 per pound, producers could receive a loan of $0.0872 per pound (after paying the 2-percent loan origination fee) and sell the crop at the market price of $0.08. Assuming that the established local repayment rate and market price are the same, a producer would repay the loan at $.08 and net $.0072 per pound from the marketing loan program.

Initial Producer Response

The majority of provision effects will be driven by changes in supply, because the programs are primarily aimed at producers. The new flexibility provisions reduce the effective price of crops that compete with oilseeds for available land resources. This encourages farmers to consider the market value and loan support levels of minor oilseeds.

Initial loan levels offer producers a degree of insurance, although the loans are not likely to encourage large shifts toward oilseeds. The marketing loan establishes a price floor for producers limiting downside price risk, while repayment rates tied to market conditions keep the seed in the marketing channel.

Together, these provisions act to reduce the influence of program crop payments on acreage allocation decisions, providing farmers with more options and an added degree of revenue protection. This could signal more oilseed acres in the coming years. Larger seed supplies at competitive prices should bolster U.S. exports because the programs are structured to keep the seed in the marketing channel.

Recent increases in U.S. oilseed acreage indicate producer response to the programs. Farmers planted 2.6 million acres of sunflowers in 1991, up 36 percent from 1990. While a long-awaited break in the dry soil conditions in the Northern Plains greatly aided the acreage expansion, the new oilseed legislation also had a significant effect.

Farmers flexed 295,000 acres to minor oilseeds in 1991, with the majority derived at the expense of wheat and barley acreage. An additional 528,000 acres of minor oilseeds were planted on program base almost equally distributed between wheat and feed grains. Farmers in the tri-State region (North Dakota, South Dakota, and Minnesota), many with experience growing minor oilseeds and access to established markets, used the 0-92 minor oilseed option the most, accounting for nearly 90 percent of national base shifted to minor oilseeds.

World Sunflowerseed Production and Trade

Sunflowerseed ranks among the top five in world oilseed production, behind soybeans, cottonseed, rapeseed, and peanuts. The former Soviet Union has been the largest producer of sunflowerseed, sunflowerseed oil, and sunflowerseed meal. The EC generated 69 percent of world exports and 80 percent of world imports during 1987-91 (including intra-EC trade), although the EC produced only 19 percent of world sunflowerseed output.

World Production

Sunflowerseed production constitutes 10 percent of world oilseed output. World production of sunflowerseed has been rising, doubling over the past 15 years (table 19). Over the past 5 years, the former Soviet Union, the EC-12 (all 12 EC countries), Argentina, and Eastern Europe have produced 75 percent of world sunflowerseed.

Sunflowerseed

Annual world production of sunflowerseed averaged 13 million metric tons during 1976-80, and rose to an average 21 million tons for 1987-91 (table 19). Production has expanded since the late 1970's among all major producers except the United States, where output declined during the 1980's as farmers focused on program crops to maintain their base acreage. Among the top five producers, output has increased tenfold in the EC and China and nearly fivefold in Argentina since the early 1970's. The former Soviet Union remains the leading producer, although its production share is declining, followed by the EC, Argentina, and Eastern Europe. Production in Turkey increased throughout the 1980's, surpassing the declining U.S. output and

Table 19--World sunflowerseed production, major producers, marketing years 1972-91

Marketing year[1]	Former Soviet Union	EC-12[2]	Argentina	Eastern Europe	China	United States	Turkey	India	South Africa	Other	World
					1,000 metric tons						
1972/73	5,048	328	880	1,759	150	334	560	35	233	434	9,761
1973/74	7,385	395	970	1,797	150	353	560	42	263	340	12,255
1974/75	6,784	385	732	1,470	150	272	420	45	209	346	10,813
1975/76	4,990	571	1,085	1,584	150	541	488	47	255	342	10,053
1976/77	5,277	435	900	1,672	150	463	505	50	471	301	10,224
1977/78	5,904	517	1,600	1,931	200	1,330	455	52	444	510	12,943
1978/79	5,333	605	1,430	1,962	279	1,823	485	55	312	559	12,843
1979/80	5,414	732	1,650	2,271	340	3,309	590	32	328	670	15,336
1980/81	4,618	807	1,260	1,980	910	1,697	750	66	517	636	13,241
1981/82	4,678	901	1,980	2,254	1,332	2,035	575	159	254	657	14,825
1982/83	5,341	1,512	2,400	2,178	1,286	2,419	600	230	202	523	16,691
1983/84	5,063	1,757	2,200	1,927	1,340	1,451	685	300	180	607	15,510
1984/85	4,527	2,299	3,400	2,110	1,704	1,698	710	440	235	863	17,986
1985/86	5,260	2,821	4,100	2,023	1,732	1,430	700	280	272	942	19,560
1986/87	5,258	3,278	2,500	2,861	1,544	1,214	940	436	404	817	19,252
1987/88	6,075	4,161	2,800	2,395	1,241	1,183	895	635	540	989	20,914
1988/89	6,200	3,986	3,200	2,127	1,180	813	1,100	370	428	961	20,365
1989/90	7,070	3,540	3,800	2,285	1,064	798	1,200	631	626	877	21,891
1990/91	6,559	4,264	4,200	2,104	1,339	1,031	860	889	589	1,062	22,897
1991/92[3]	5,640	3,973	3,200	2,187	1,100	1,637	650	1,150	173	928	20,638

[1]Based on aggregate of differing local marketing years. [2]Data for all 12 EC countries, 1972-92. [3]Preliminary.
Source: U.S. Department of Agriculture, Foreign Agricultural Service, Oilseeds and Products Division. Production, Supply, and Distribution Database. Sept. 1992.

challenging China for the fifth-ranked position among world producers.

Sunflowerseed is the former Soviet Union's primary oilseed crop, serving as its major source of vegetable and industrial oils. Soviet sunflowerseed production had been unrivaled during the early 1970's and late 1980's, peaking in 1973 at nearly 7.4 million tons. Although still the world's largest sunflowerseed producer, Soviet output as a world share has declined as other countries have expanded production (table 20). The Soviets reduced production area in an attempt to control disease and increase yields. Areas previously sown to sunflowerseed have been reallocated to rapeseed and non-oilseeds (Bickerton, 1987). Sunflowerseed harvested area in the Soviet Union declined from the late 1960's to the mid-1980's; however, Soviet sunflowerseed area has rebounded since 1986 (table 21). Soviet yields rose through the 1980's (table 22), helping to push production up to 7 million metric tons in 1990 (table 19).

The EC has increased output since the early 1970's by expanding harvested area and boosting yields, in response to generous crushing subsidies and developments in the grains sector that made oilseeds an attractive cropping alternative. EC production passed that of Argentina and Eastern Europe in the mid-1980's, making the EC the world's second-largest producer. Argentina has also been increasing production, area, and yields, outpacing East European production since 1982. Sunflowerseed production in China, Turkey, India, and South Africa has generally been rising over the past 20 years. Of the major producers, only the United States has shown a 10-year decline in output.

Sunflowerseed Oil and Meal

The major sunflowerseed producers are also the major producers of sunflowerseed oil and meal (tables 23 and 24). In the past, sunflowerseed provided almost three-fourths of all Soviet vegetable oil. In recent years, its share declined because of the drop in sunflowerseed production and the steady rise in the volume of vegetable oil processed from imported soybeans (Bickerton, 1987).

Sunflowerseed is the second-most important oilseed produced in the EC, following rapeseed, but ahead of soybeans. The EC's oilseed stabilizer, instituted following

Table 20--Producer share of world sunflowerseed production, 1972-76 and 1987-91

Country	Share of world production 1972-76	1987-91
	Percent	
Former Soviet Union	55	30
EC-12[1]	4	19
Argentina	9	16
Eastern Europe	16	10
China	1	6
United States	4	5
Turkey	5	4
India	--	3
South Africa	3	2
Other	3	5
World	100	100

-- = Less than 0.5 percent.
[1]Data for all 12 EC countries, 1972-91.
Source: Table 19.

February 1988 budget reforms, reduces support (target and intervention) prices when production exceeds target levels. EC spending on oilseed support programs more than tripled since 1984 and took an increasing share of total EC spending on agriculture. Until the introduction of stabilizers, oilseed expenditures remained unchecked as production grew. Forecast 1990/91 EC sunflowerseed output will exceed the production ceiling, resulting in about a 22-percent cut in support prices for the 1991/92 marketing year (Normile, 1990).

More than 80 percent of all oilseed meal consumed in the former Soviet Union came from domestic cottonseed and sunflowerseed until the mid-1970's. However, in the wake of the 1975 grain shortfall, the Soviets began to increase their imports of oilseeds, primarily soybeans. Soybean meal has grown to about 30 percent of total Soviet oilseed meal production with most of this production coming from imported soybeans. Cottonseed remains the largest domestic source of processed oilseed meal, accounting for about one-third of total production since 1981. Sunflowerseed meal ranks second among domestic sources and constitutes slightly more than one-quarter of overall Soviet oilseed meal production (Bickerton, 1987).

World Trade

Sunflowerseed trade constitutes about 5 percent of world oilseed trade, behind soybeans (75 percent) and rapeseed (11 percent). The largest producer, the former Soviet Union, is a net importer of both sunflowerseed oil and meal. Sunflowerseed oil comprises around 12 percent of world vegetable oil trade, following palm oil (34 percent) and soybean oil (20 percent). Sunflowerseed meal makes up only 5 percent of world protein meal trade, trailing soybean meal (68 percent), fish meal (8 percent), and rapeseed meal (6 percent).

Exporters

Argentina and the EC (including intra-EC trade) are the major exporters of sunflowerseed, sunflowerseed meal, and oil, with 1991 combined exports forecast to exceed 85 percent of world total for each of these three products.

Sunflowerseed. Although the EC replaced the United States as the leading sunflowerseed exporter in 1985, the EC remains a net importer (table 25). U.S. sunflowerseed exports have fallen since 1979 as U.S. production declined, allowing Argentina's seed exports to surpass U.S. shipments in the late 1980's. The United States, with 8 percent of world sunflowerseed exports, ranks third behind the EC (65 percent) and Argentina (14 percent).

Sunflowerseed oil. Argentina, the leading sunflowerseed exporter, averaged a 38-percent share of the world total during 1987-90 (table 26). The EC followed with 30 percent, and the United States averaged 11 percent in 1987-90. EC and U.S. shares of world exports rose in the 1980's, while East European and Soviet shares declined (tables 26, 27, 28). Turkey, a newcomer among sunflowerseed oil exporters, advanced to 1 percent of world exports in the 1980's.

Sunflowerseed meal. Argentina continued to dominate world sunflowerseed meal exports, with 57 percent of the world total in 1991/92 (table 29). Argentina's major competitor is the EC, whose export share was 27 percent of the world total in 1991/92. Some major producers of sunflowerseed meal, such as the former Soviet Union, Eastern Europe, and even the EC, consume most of their output.

Importers

Sunflowerseed. The EC buys 77 percent of the world's sunflowerseed exports (including intra-EC trade), and is a net importer (tables 25, 30). Mexico has been the largest market outside the EC since the late 1970's, and takes about 10 percent of world exports. Eastern Europe, like the EC, is a net importer of sunflowerseed.

Sunflowerseed oil. Sunflowerseed oil imports are not as concentrated in a few markets as are seed and meal imports. The EC took one-half of the world's sunflowerseed oil imports during 1972-76 (table 27). By 1987-90, the EC share had fallen to less than one-fourth of world imports, still ahead of the former Soviet Union and Egypt,

whose individual market shares had risen to 12 and 11 percent, respectively, in 1987-90 (table 26). East European markets that took one-third of world imports in 1962-66 had withered to importing only 5 percent of an increasing world volume in 1987-90 (tables 26, 28).

Sunflowerseed meal. The EC also dominates the world's sunflowerseed meal imports, taking almost 94 percent (table 31). Although a major meal exporter, the EC is a net importer and major consumer of sunflowerseed meal. Cuba has about a 4-percent share of the world's import market. Cuban imports have grown rapidly since the late 1970's, making Cuba the leading sunflowerseed meal importer outside the EC.

Table 21--World sunflowerseed harvested area, major producers, marketing years 1972-91

Marketing year[1]	Former Soviet Union	EC-12[2]	Argentina	Eastern Europe	China	United States	Turkey	India	South Africa	Other	World
					1,000 hectares						
1972/73	4,394	407	1,338	1,111	200	329	495	80	346	718	9,418
1973/74	4,745	479	1,190	1,095	200	301	481	85	241	545	9,362
1974/75	4,686	504	1,005	1,088	200	263	425	90	239	585	9,085
1975/76	4,045	892	1,258	1,076	200	481	418	95	288	573	9,326
1976/77	4,534	594	1,233	1,063	200	425	445	100	389	553	9,536
1977/78	4,574	626	2,000	1,106	250	959	374	105	449	748	11,191
1978/79	4,558	667	1,557	1,158	320	1,192	415	107	306	775	11,055
1979/80	4,334	780	1,855	1,255	367	2,189	445	61	336	847	12,469
1980/81	4,353	826	1,280	1,228	867	1,490	575	119	383	835	11,956
1981/82	4,235	974	1,673	1,283	1,040	1,542	500	282	307	879	12,715
1982/83	4,250	1,227	1,902	1,206	814	1,912	530	462	325	758	13,386
1983/84	4,266	1,472	1,989	1,137	733	1,240	550	696	322	864	13,269
1984/85	3,907	1,646	2,350	1,158	1,013	1,494	565	835	310	1,072	14,350
1985/86	4,053	2,020	3,046	1,211	1,474	1,151	643	750	323	1,138	15,809
1986/87	3,848	2,148	1,800	1,332	1,107	791	689	992	383	1,022	14,112
1987/88	4,156	2,300	2,058	1,375	887	718	775	1,651	462	1,140	15,522
1988/89	4,280	2,164	2,200	1,311	830	777	700	1,104	410	1,184	14,960
1989/90	4,460	2,125	2,800	1,265	716	723	800	1,192	519	1,043	15,643
1990/91	4,665	2,607	2,300	1,227	713	749	700	1,642	575	1,233	16,401
1991/92[3]	4,500	2,349	2,500	1,266	750	1,081	550	1,900	454	1,144	16,494

[1]Based on aggregate of differing local marketing years. [2]Data for all 12 EC countries, 1972-92. [3]Preliminary.
Source: U.S. Department of Agriculture, Foreign Agricultural Service, Oilseeds and Products Division. Production, Supply, and Distribution Database. Sept. 1992.

Table 22--World sunflowerseed yields, major producers, marketing years 1972-91

Marketing year[1]	Former Soviet Union	EC-12[2]	Argentina	Eastern Europe	China	United States	Turkey	India	South Africa	World
					Metric tons/hectare					
1972/73	1.15	0.81	0.66	1.58	0.75	1.02	1.13	0.44	0.67	1.04
1973/74	1.56	.82	.82	1.64	.75	1.17	1.16	.49	1.09	1.31
1974/75	1.45	.76	.73	1.35	.75	1.03	.99	.50	.87	1.19
1975/76	1.23	.64	.86	1.47	.75	1.12	1.17	.49	.89	1.08
1976/77	1.16	.73	.73	1.57	.75	1.09	1.13	.50	1.21	1.07
1977/78	1.29	.83	.80	1.75	.80	1.39	1.22	.50	.99	1.16
1978/79	1.17	.91	.92	1.69	.87	1.53	1.17	.51	1.02	1.16
1979/80	1.25	.94	.89	1.81	.93	1.51	1.33	.52	.98	1.23
1980/81	1.06	.98	.98	1.61	1.05	1.14	1.30	.55	1.35	1.11
1981/82	1.10	.93	1.18	1.76	1.28	1.32	1.15	.56	.83	1.17
1982/83	1.26	1.23	1.26	1.81	1.58	1.27	1.13	.50	.62	1.25
1983/84	1.19	1.19	1.11	1.69	1.83	1.17	1.25	.43	.56	1.17
1984/85	1.16	1.40	1.45	1.82	1.68	1.14	1.26	.53	.76	1.25
1985/86	1.30	1.40	1.35	1.67	1.18	1.24	1.09	.37	.84	1.24
1986/87	1.37	1.53	1.39	2.15	1.39	1.53	1.36	.44	1.05	1.36
1987/88	1.46	1.81	1.36	1.74	1.40	1.65	1.15	.38	1.17	1.35
1988/89	1.45	1.84	1.45	1.62	1.42	1.05	1.57	.34	1.04	1.36
1989/90	1.59	1.67	1.36	1.81	1.49	1.10	1.50	.53	1.21	1.40
1990/91	1.41	1.64	1.83	1.71	1.88	1.38	1.23	.54	1.02	1.40
1991/92[3]	1.25	1.69	1.28	1.73	1.47	1.51	1.18	.61	.38	1.25

[1]Based on aggregate of differing local marketing years. [2]Data for all 12 EC countries, 1972-92. [3]Preliminary.
Source: U.S. Department of Agriculture, Foreign Agricultural Service, Oilseeds and Products Division. Production, Supply, and Distribution Database. Sept. 1992.

Table 23--World sunflowerseed oil production, major producers, marketing years 1972-91

Marketing year[1]	Former Soviet Union	EC-12[2]	Argentina	Eastern Europe	Turkey	United States	India	South Africa	China	Other	World
					1,000 metric tons						
1972/73	1,736	243	328	670	226	30	11	88	24	137	3,493
1973/74	2,540	266	328	685	226	30	14	90	23	106	4,308
1974/75	2,454	229	243	557	170	12	15	80	23	112	3,895
1975/76	1,717	338	293	603	197	72	16	84	23	113	3,456
1976/77	1,816	299	357	638	204	14	17	140	22	86	3,593
1977/78	2,031	540	385	742	184	86	18	141	31	174	4,332
1978/79	1,834	696	518	743	196	115	19	150	43	253	4,567
1979/80	1,852	901	571	806	196	224	11	180	52	212	5,005
1980/81	1,483	864	427	739	245	298	22	178	141	263	4,660
1981/82	1,602	787	683	838	223	137	54	129	207	345	5,005
1982/83	1,775	936	904	821	228	303	78	80	200	335	5,660
1983/84	1,682	1,006	812	718	275	204	102	77	208	415	5,499
1984/85	1,495	1,197	1,261	738	284	219	151	99	264	475	6,183
1985/86	1,747	1,260	1,408	809	279	265	95	92	270	445	6,670
1986/87	1,714	1,408	919	973	380	266	147	137	240	373	6,557
1987/88	2,005	1,640	1,033	908	355	377	210	182	191	375	7,276
1988/89	1,986	1,716	1,365	813	312	235	122	166	181	291	7,187
1989/90	2,332	1,579	1,380	892	540	215	205	257	162	290	7,852
1990/91	2,200	1,779	1,380	855	406	243	290	247	207	391	7,998
1991/92[3]	1,883	1,714	1,245	834	263	387	375	75	160	343	7,279

[1]Based on aggregate of differing local marketing years. [2]Data for all 12 EC countries, 1972-92. [3]Preliminary.
Source: U.S. Department of Agriculture, Foreign Agricultural Service, Oilseeds and Products Division. Production, Supply, and Distribution Database. Sept. 1992.

Table 24--World sunflowerseed meal production, major producers, marketing years 1972-91

Marketing year[1]	EC-12[2]	Former Soviet Union	Argentina	Eastern Europe	China	Turkey	United States	India	South Africa	Other	World
					1,000 metric tons						
1972/73	305	1,857	423	618	62	200	45	16	88	178	3,792
1973/74	330	2,718	425	619	61	200	46	19	95	137	4,650
1974/75	267	2,496	275	510	61	150	18	20	87	144	4,028
1975/76	413	1,836	371	558	61	174	108	21	104	137	3,783
1976/77	374	1,942	479	591	59	181	21	22	173	111	3,953
1977/78	708	2,173	513	674	80	163	131	23	156	232	4,853
1978/79	951	1,962	643	681	113	173	180	24	144	308	5,179
1979/80	1,248	1,967	689	728	138	252	359	14	147	250	5,792
1980/81	1,198	1,550	525	642	372	315	439	29	153	341	5,564
1981/82	1,057	1,674	797	749	545	210	201	69	111	438	5,851
1982/83	1,228	1,855	1,030	844	526	216	434	100	76	400	6,709
1983/84	1,337	1,758	943	646	549	248	265	131	67	490	6,434
1984/85	1,565	1,565	1,380	718	696	257	321	194	88	561	7,345
1985/86	1,526	1,826	1,512	730	711	253	357	122	119	525	7,681
1986/87	1,710	1,792	1,002	922	632	344	305	190	176	458	7,531
1987/88	2,029	2,050	1,110	832	504	330	426	265	234	439	8,219
1988/89	2,085	1,893	1,435	759	476	289	298	158	176	349	7,918
1989/90	1,964	2,173	1,470	988	428	493	264	260	239	352	8,631
1990/91	2,321	2,050	1,550	906	545	377	293	370	238	483	9,133
1991/92[3]	2,230	1,753	1,200	907	425	244	472	475	72	424	8,202

[1]Based on aggregate of differing local marketing years. [2]Data for all 12 EC countries, 1972-92. [3]Preliminary.
Source: U.S. Department of Agriculture, Foreign Agricultural Service, Oilseeds and Products Division. Production, Supply, and Distribution Database. Sept. 1992.

Table 25--World sunflowerseed exports, major exporters, marketing years 1972-91

Marketing year[1]	EC-12[2]	Argentina	United States	Eastern Europe	Australia	Canada	China	Other	World
					1,000 metric tons				
1972/73	58	0	179	69	0	36	0	81	423
1973/74	46	0	207	48	0	18	2	70	391
1974/75	10	0	151	33	0	6	3	67	270
1975/76	40	0	306	33	0	7	3	27	416
1976/77	17	11	337	41	0	9	7	56	478
1977/78	18	189	942	39	0	49	5	77	1,319
1978/79	41	2	1,366	104	52	68	6	15	1,654
1979/80	76	1	1,820	148	93	124	6	15	2,283
1980/81	133	25	1,505	99	0	78	10	107	1,957
1981/82	249	19	1,555	135	22	81	12	16	2,089
1982/83	438	3	1,348	127	0	40	12	11	1,979
1983/84	591	146	1,044	95	26	31	10	14	1,957
1984/85	615	389	991	78	27	53	15	9	2,177
1985/86	969	517	365	65	0	16	20	23	1,975
1986/87	1,231	47	304	183	17	8	15	8	1,813
1987/88	1,636	52	270	106	85	14	20	37	2,220
1988/89	1,418	115	86	56	95	14	26	55	1,865
1989/90	1,167	372	96	75	23	15	19	74	1,841
1990/91	1,149	338	121	44	39	41	19	22	1,773
1991/92[3]	1,164	250	147	132	10	45	20	6	1,794

[1]Based on aggregate of differing local marketing years. [2]Data for all 12 EC countries, 1972-92. [3]Preliminary.
Source: U.S. Department of Agriculture, Foreign Agricultural Service, Oilseeds and Products Division. Production, Supply, and Distribution Database. Sept. 1992.

Table 26--World sunflowerseed oil trade, annual averages, 1982-86 and 1987-90[1]

Importers	Exporters: Argentina 1982-86	Argentina 1987-90	EC-12[2] 1982-86	EC-12[2] 1987-90	United States 1982-86	United States 1987-90	Eastern Europe 1982-86	Eastern Europe 1987-90	USSR 1982-86	USSR 1987-90	Other 1982-86	Other 1987-90	Total[3] 1982-86	Total[3] 1987-90
EC-12[2] (1,000 metric tons)	87	49	306	439	7	30	21	6	11	7	23	13	454	544
% of EC-12[2] imports	19	9	67	81	1	5	5	1	3	1	5	2	100	100
% of exporter's exports	14	6	75	63	4	11	9	2	16	7	42	11	29	23
USSR (1,000 metric tons)	196	188	8	16	6	0	16	39	0	0	0	35	227	278
% of USSR imports	87	68	4	6	3	0	7	14	0	0	0	13	100	100
% of exporter's exports	31	21	2	2	4	0	6	14	0	0	0	30	14	12
Egypt (1,000 metric tons)	37	155	31	47	29	14	29	12	4	26	9	4	139	259
% of Egyptian imports	27	60	22	18	21	6	21	5	3	10	7	1	100	100
% of exporter's exports	6	17	8	7	16	6	12	4	5	26	17	3	9	11
Mexico (1,000 metric tons)	23	66	0	6	31	67	0	0	0	5	0	2	54	146
% of Mexican imports	43	45	0	4	57	46	0	0	0	3	0	1	100	100
% of exporter's exports	4	7	0	1	18	26	0	0	0	5	0	1	3	6
Turkey (1,000 metric tons)	14	58	13	43	2	13	11	26	4	10	1	8	44	157
% of Turkish imports	31	37	29	27	4	8	24	16	9	6	3	5	100	100
% of exporter's exports	2	7	3	6	1	5	4	9	6	10	2	7	3	7
E. Europe (1,000 metric tons)	10	8	5	19	0	0	64	77	17	21	1	2	97	126
% of East European imports	11	6	5	15	0	0	66	61	17	16	1	1	100	100
% of exporter's exports	2	1	1	3	0	0	26	28	23	21	3	1	6	5
Cuba (1,000 metric tons)	80	98	0	9	0	0	0	0	15	9	0	1	94	116
% of Cuban imports	84	84	0	8	0	0	0	0	16	7	0	1	100	100
% of exporter's exports	13	11	0	1	0	0	0	0	21	9	0	1	6	5
Other (1,000 metric tons)	179	266	48	119	102	136	103	116	21	22	19	52	471	712
% of all "other" imports	38	37	10	17	22	19	22	16	4	3	4	7	100	100
% of exporter's exports	29	30	12	17	58	52	42	42	29	22	36	45	30	30
Total[3] (1,000 metric tons)	626	888	410	697	176	260	244	276	71	99	54	116	1,581	2,337
% of world imports	40	38	26	30	11	11	15	12	4	4	3	5	100	100
% of exporter's exports	100	100	100	100	100	100	100	100	100	100	100	100	100	100

[1]For example, the EC-12's 1982-86 average annual imports of 87,000 metric tons of sunflowerseed oil from Argentina (column 1, row 1) were 19 percent of EC sunflowerseed oil imports (column 1, row 2) and 14 percent of Argentine sunflowerseed oil exports (column 1, row 3). [2]Includes data for all 12 EC countries, 1982-90. [3]Data may not add to totals because of rounding.

Source: United Nations, Department of International Economic and Social Affairs. "Commodity Trade Statistics," Statistical Papers, Series D, 1962-90. Calendar year commodity import data expanded by Arthur B. Mackie and Samuel D. Calhoun, Agriculture and Trade Analysis Division, Economic Research Service, U.S. Department of Agriculture, to include nonreporting countries.

Table 27--World sunflowerseed oil trade, annual averages, 1972-76 and 1977-81[1]

Importers	Exporters: Argentina 1972-76	Argentina 1977-81	EC-12[2] 1972-76	EC-12[2] 1977-81	United States 1972-76	United States 1977-81	Eastern Europe 1972-76	Eastern Europe 1977-81	USSR 1972-76	USSR 1977-81	Other 1972-76	Other 1977-81	Total[3] 1972-76	Total[3] 1977-81
EC-12[2] (1,000 metric tons)	9	35	89	178	8	6	78	35	140	22	3	9	327	285
% of EC-12[2] imports	3	12	27	62	2	2	24	12	43	8	1	3	100	100
% of exporter's exports	70	17	79	83	42	6	52	20	38	16	31	43	49	33
USSR (1,000 metric tons)	0	57	0	1	0	0	0	1	0	0	0	0	0	59
% of USSR imports	0	96	0	2	0	0	0	2	0	0	0	0	0	100
% of exporter's exports	0	27	0	1	0	0	0	1	0	0	0	0	0	7
Egypt (1,000 metric tons)	--	10	0	--	4	21	10	10	0	0	--	1	14	41
% of Egyptian imports	3	25	0	1	28	50	66	23	0	0	3	1	100	100
% of exporter's exports	4	5	0	--	21	22	6	6	0	0	4	3	2	5
Mexico (1,000 metric tons)	0	0	0	0	0	2	0	0	0	0	0	0	0	2
% of Mexican imports	0	0	0	0	0	100	0	0	0	0	0	0	0	100
% of exporter's exports	0	0	0	0	0	2	0	0	0	0	0	0	0	--
Turkey (1,000 metric tons)	0	3	3	5	1	0	3	2	1	0	2	1	9	11
% of Turkish imports	0	25	28	48	6	0	33	17	12	0	20	10	100	100
% of exporter's exports	0	1	2	3	3	0	2	1	--	0	18	6	1	1
E. Europe (1,000 metric tons)	1	13	1	1	0	1	15	42	99	40	2	2	119	100
% of East European imports	1	14	1	1	0	1	13	42	83	40	2	2	100	100
% of exporter's exports	7	6	1	1	0	1	10	24	27	28	24	9	18	12
Cuba (1,000 metric tons)	0	2	0	0	0	0	0	0	60	69	0	0	60	71
% of Cuban imports	0	3	0	0	0	0	0	0	100	97	0	0	100	100
% of exporter's exports	0	1	0	0	0	0	0	0	16	49	0	0	9	8
Other (1,000 metric tons)	3	92	20	29	6	64	45	84	64	9	2	8	140	286
% of all "other" imports	2	32	14	10	5	22	32	29	46	3	2	3	100	100
% of exporter's exports	19	43	18	14	34	68	30	48	18	6	23	40	21	33
Total[3] (1,000 metric tons)	14	212	112	215	19	94	151	173	363	140	10	20	668	855
% of world imports	2	25	17	25	3	11	23	20	54	16	1	2	100	100
% of exporter's exports	100	100	100	100	100	100	100	100	100	100	100	100	100	100

-- = Less than 0.5.

[1]For example, the EC-12's 1972-76 average annual imports of 9,000 metric tons of sunflowerseed oil from Argentina (column 1, row 1) were 3 percent of EC sunflowerseed oil imports (column 1, row 2) and 70 percent of Argentine sunflowerseed oil exports (column 1, row 3). [2]Includes data for all 12 EC countries, 1972-81. [3]Data may not add to totals because of rounding.

Source: United Nations, Department of International Economic and Social Affairs. "Commodity Trade Statistics," Statistical Papers, Series D, 1962-90. Calendar year commodity import data expanded by Arthur B. Mackie and Samuel D. Calhoun, Agriculture and Trade Analysis Division, Economic Research Service, U.S. Department of Agriculture, to include nonreporting countries.

Table 28--World sunflowerseed oil trade, annual averages, 1962-66 and 1967-71[1]

Importers	Exporters: Argentina 1962-66	Argentina 1967-71	EC-12[2] 1962-66	EC-12[2] 1967-71	United States 1962-66	United States 1967-71	Eastern Europe 1962-66	Eastern Europe 1967-71	USSR 1962-66	USSR 1967-71	Other 1962-66	Other 1967-71	Total[3] 1962-66	Total[3] 1967-71
EC-12[2] (1,000 metric tons)	14	27	5	56	0	--	28	122	58	130	1	1	106	335
% of EC-12[2] imports	13	8	5	17	0	--	26	36	54	39	1	--	100	100
% of exporter's exports	56	46	53	67	0	15	42	61	22	26	49	7	29	40
USSR (1,000 metric tons)	0	0	0	0	0	0	1	--	0	0	0	0	1	--
% of USSR imports	0	0	0	0	0	0	100	100	0	0	0	0	100	100
% of exporter's exports	0	0	0	0	0	0	2	--	0	0	0	0	--	--
Egypt (1,000 metric tons)	0	0	0	--	3	0	0	--	2	31	0	1	5	32
% of Egyptian imports	0	0	0	1	54	0	0	--	46	97	0	2	100	100
% of exporter's exports	0	0	0	--	73	0	0	--	1	6	0	4	1	4
Mexico (1,000 metric tons)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% of Mexican imports	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% of exporter's exports	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turkey (1,000 metric tons)	--	0	1	0	1	0	0	0	2	1	0	0	4	1
% of Turkish imports	5	0	29	0	20	0	0	4	46	96	0	0	100	100
% of exporter's exports	1	0	12	0	22	0	0	--	1	--	0	0	1	--
E. Europe (1,000 metric tons)	0	0	0	2	0	0	7	22	115	168	0	5	122	196
% of East European imports	0	0	0	1	0	0	6	11	94	85	0	2	100	100
% of exporter's exports	0	0	0	3	0	0	11	11	45	34	0	33	33	23
Cuba (1,000 metric tons)	0	0	0	0	0	0	0	0	40	59	0	0	40	59
% of Cuban imports	0	0	0	0	0	0	0	0	100	100	0	0	100	100
% of exporter's exports	0	0	0	0	0	0	0	0	16	12	0	0	11	7
Other (1,000 metric tons)	11	31	3	24	--	1	30	55	40	104	1	8	86	224
% of all "other" imports	13	14	4	11	--	1	35	25	47	47	1	4	100	100
% of exporter's exports	43	54	34	29	5	85	45	28	16	21	51	55	23	26
Total[3] (1,000 metric tons)	25	58	10	83	4	1	66	199	258	493	2	14	366	848
% of world imports	7	7	3	10	1	--	18	23	71	58	--	2	100	100
% of exporter's exports	100	100	100	100	100	100	100	100	100	100	100	100	100	100

-- = Less than 0.5.

[1]For example, the EC-12's 1962-66 average annual imports of 14,000 metric tons of sunflowerseed oil from Argentina (column 1, row 1) were 13 percent of EC sunflowerseed oil imports (column 1, row 2) and 56 percent of Argentine sunflowerseed oil exports (column 1, row 3). [2]Includes data for all 12 EC countries, 1962-71. [3]Data may not add to totals because of rounding.

Source: United Nations, Department of International Economic and Social Affairs. "Commodity Trade Statistics," Statistical Papers, Series D, 1962-90. Calendar year commodity import data expanded by Arthur B. Mackie and Samuel D. Calhoun, Agriculture and Trade Analysis Division, Economic Research Service, U.S. Department of Agriculture, to include nonreporting countries.

Table 29--World sunflowerseed meal exports, major exporters, marketing years 1972-91

Marketing year[1]	Argentina	EC-12[2]	India	China	Eastern Europe	United States	Australia	Other	World
					1,000 metric tons				
1972/73	329	67	2	0	0	0	0	9	407
1973/74	309	59	2	0	0	0	0	7	377
1974/75	223	17	3	0	1	0	0	6	250
1975/76	303	79	3	0	0	0	0	16	401
1976/77	433	33	2	0	0	0	0	8	476
1977/78	481	147	2	0	0	0	0	18	648
1978/79	567	252	3	0	0	0	0	21	843
1979/80	632	218	3	0	0	0	0	8	861
1980/81	469	251	10	0	0	0	0	9	739
1981/82	662	231	15	0	0	0	0	15	923
1982/83	965	294	60	0	0	0	0	2	1,321
1983/84	855	314	40	18	0	18	0	1	1,246
1984/85	1,204	428	30	0	0	14	0	2	1,678
1985/86	1,397	409	25	0	0	44	20	10	1,905
1986/87	928	407	30	40	32	42	11	6	1,496
1987/88	1,050	412	65	10	39	47	0	4	1,627
1988/89	1,280	397	80	80	40	6	0	14	1,897
1989/90	1,403	396	70	80	28	3	0	9	1,989
1990/91	1,475	565	80	120	10	5	0	20	2,275
1991/92[3]	1,150	544	200	75	10	32	0	9	2,020

[1]Based on aggregate of differing local marketing years. [2]Data for all 12 EC countries, 1972-92. [3]Preliminary.
Source: U.S. Department of Agriculture, Foreign Agricultural Service, Oilseeds and Products Division. Production, Supply, and Distribution Database. Sept. 1992.

Table 30--World sunflowerseed imports, major importers, marketing years 1972-91

Marketing year[1]	EC-12[2]	Mexico	Eastern Europe	United States	Canada	Angola	Switzerland	Other	World
					1,000 metric tons				
1972/73	392	0	108	2	0	0	0	15	517
1973/74	353	0	80	2	0	0	0	11	446
1974/75	238	0	74	1	0	0	0	9	322
1975/76	352	0	73	2	0	0	2	24	453
1976/77	397	0	84	2	0	0	9	15	507
1977/78	970	78	86	3	0	0	22	12	1,171
1978/79	1,305	263	153	7	0	0	24	53	1,805
1979/80	1,733	239	48	10	0	0	21	91	2,142
1980/81	1,643	232	58	28	23	0	15	27	2,026
1981/82	1,459	621	102	32	17	1	12	87	2,331
1982/83	1,341	485	43	40	8	2	10	30	1,959
1983/84	1,282	551	44	31	11	6	12	23	1,960
1984/85	1,371	671	32	26	0	10	13	27	2,150
1985/86	1,313	402	123	26	11	12	12	43	1,942
1986/87	1,471	344	19	8	12	12	13	42	1,921
1987/88	1,706	270	51	10	25	12	12	57	2,143
1988/89	1,565	78	41	25	20	12	14	54	1,809
1989/90	1,516	143	104	20	15	12	9	46	1,865
1990/91	1,440	203	83	40	23	12	9	95	1,905
1991/92[3]	1,614	230	99	10	15	12	9	114	2,103

[1]Based on aggregate of differing local marketing years. [2]Data for all 12 EC countries, 1972-92. [3]Preliminary.
Source: U.S. Department of Agriculture, Foreign Agricultural Service, Oilseeds and Products Division. Production, Supply, and Distribution Database. Sept. 1992.

Table 31--World sunflowerseed meal imports, major importers, marketing years 1964-91

Marketing year[1]	EC-12[2]	Cuba	Eastern Europe	Former Soviet Union	Canada	Other	World
				1,000 metric tons			
1964/65	119	0	0	0	0	13	132
1965/66	204	0	0	0	0	40	244
1966/67	232	0	0	0	0	44	276
1967/68	205	0	0	0	0	23	228
1968/69	183	0	0	0	0	1	184
1969/70	194	0	0	0	0	3	197
1970/71	127	0	0	0	0	3	130
1971/72	119	0	3	0	0	0	122
1972/73	369	0	108	0	0	0	477
1973/74	335	0	89	0	0	0	424
1974/75	276	0	69	0	0	0	345
1975/76	327	0	52	0	0	0	379
1976/77	470	0	59	0	0	0	529
1977/78	643	28	63	0	0	0	734
1978/79	716	19	78	13	0	0	826
1979/80	829	13	125	16	0	0	983
1980/81	814	18	43	10	0	5	890
1981/82	883	15	41	25	0	5	969
1982/83	1,280	29	73	15	0	63	1,460
1983/84	1,134	39	80	15	0	28	1,296
1984/85	1,581	33	20	0	0	8	1,642
1985/86	1,723	102	29	10	20	10	1,894
1986/87	1,462	104	30	11	12	7	1,626
1987/88	1,470	124	41	17	12	12	1,676
1988/89	1,568	110	33	7	11	51	1,780
1989/90	1,822	120	11	0	0	40	1,993
1990/91	1,960	85	6	0	0	64	2,115
1991/92[3]	2,018	80	4	0	0	52	2,154

[1]Based on aggregate of differing local marketing years. [2]Data for all 12 EC countries, 1964-92. [3]Preliminary.
Source: U.S. Department of Agriculture, Foreign Agricultural Service, Oilseeds and Products Division. Production, Supply, and Distribution Database. Sept. 1992.

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Appendix: Processing Cost Assumptions

The processing plant in the analysis is assumed to be a prepress solvent extraction plant located in North Dakota. The costs contained in this section are an update based on estimates contained in an earlier publication, *The Economic Feasibility of Establishing Oil Sunflower Processing Plants in North Dakota*, hereafter referred to as the North Dakota study (Helgeson and others, 1977). Another study, *Economics of Vegetable Oil Processing*, which was done under contract for Oak Ridge National Laboratory and hereafter referred to as the Oak Ridge study, updated the North Dakota study using 1985 estimates (Scheithauer and Dripchak, 1985). The cost estimates used in earlier reports have been updated using 1991 price estimates.

The two studies considered four sunflowerseed processing plants of different capacities: 500 short tons/day, 1,000 short tons/day, 1,500 short tons/day, and 2,000 short tons/day. For full capacity operation, plants were assumed to operate on three shifts (24 hours a day) for 300 days a year. The average U.S. utilization rate is near 50 percent of capacity, although utilization rates may be higher for individual plants.

Appendix table 1--Sunflowerseed processing capital costs, 1991

Cost	Plant size in tons per day			
	500	1,000	1,500	2,000
	1,000 dollars			
Total equipment	5,615	7,402	9,926	11,818
Installation and freight	4,501	6,863	7,224	8,336
Buildings	1,603	2,407	3,503	4,650
Railroad track	151	151	151	151
Land	90	90	90	90
Total	11,960	16,913	20,894	25,045

Source: Updated from Delmer L. Helgeson and others. *The Economic Feasibility of Establishing Oil Sunflower Processing Plants in North Dakota.* Bulletin 503. Agricultural Experiment Station, North Dakota State University, Table 16, Apr. 1977, p. 22.

Appendix figure 1 illustrates the flow in a typical prepress/solvent extraction plant. The flow diagram shows the four stages of seed processing: storage and receiving, preparation-prepress, cake extraction, and meal conditioning and pelleting. More plants are entering the vegetable oil refining industry and are offering a refined, bleached, and deodorized product. However, when the study on which this report is based was done, the standard vegetable oil product was crude oil, which was then sent to refiners for further processing. This study consequently assumes a crude oil output.

The total capital cost component includes costs of total equipment, transportation to and installation at the construction site, structures and buildings, railroad siding to the plant, and land. The equipment costs are based on estimates used in the North Dakota study, updated to reflect 1991 prices. The resulting estimates are summarized in appendix table 1. The equipment configuration reflects the processing steps as illustrated in appendix figure 1. Installation and freight costs are estimated at 130 percent of total equipment cost. For example, a piece of equipment costing $1 million would cost $1.3 million to ship and install, for a full cost of $2.3 million. This is consistent with estimates used in the Oak Ridge study and is confirmed in *Handbook of Soy Oil Processing and Utilization* (Erickson and others, 1980).

Annual capital costs were estimated at 19.8 percent of total capital costs. Equipment life was assumed to be 20 years in all cases and the capital structure of the firm was assumed to be 30-percent equity and 70-percent debt. The actual calculation was consistent with the method in *Uniform Cost Estimation Method for Biomass Production in Conversion Technologies* (Argone National Laboratory, 1985). Other fixed cost items included insurance, property taxes, and administrative labor.

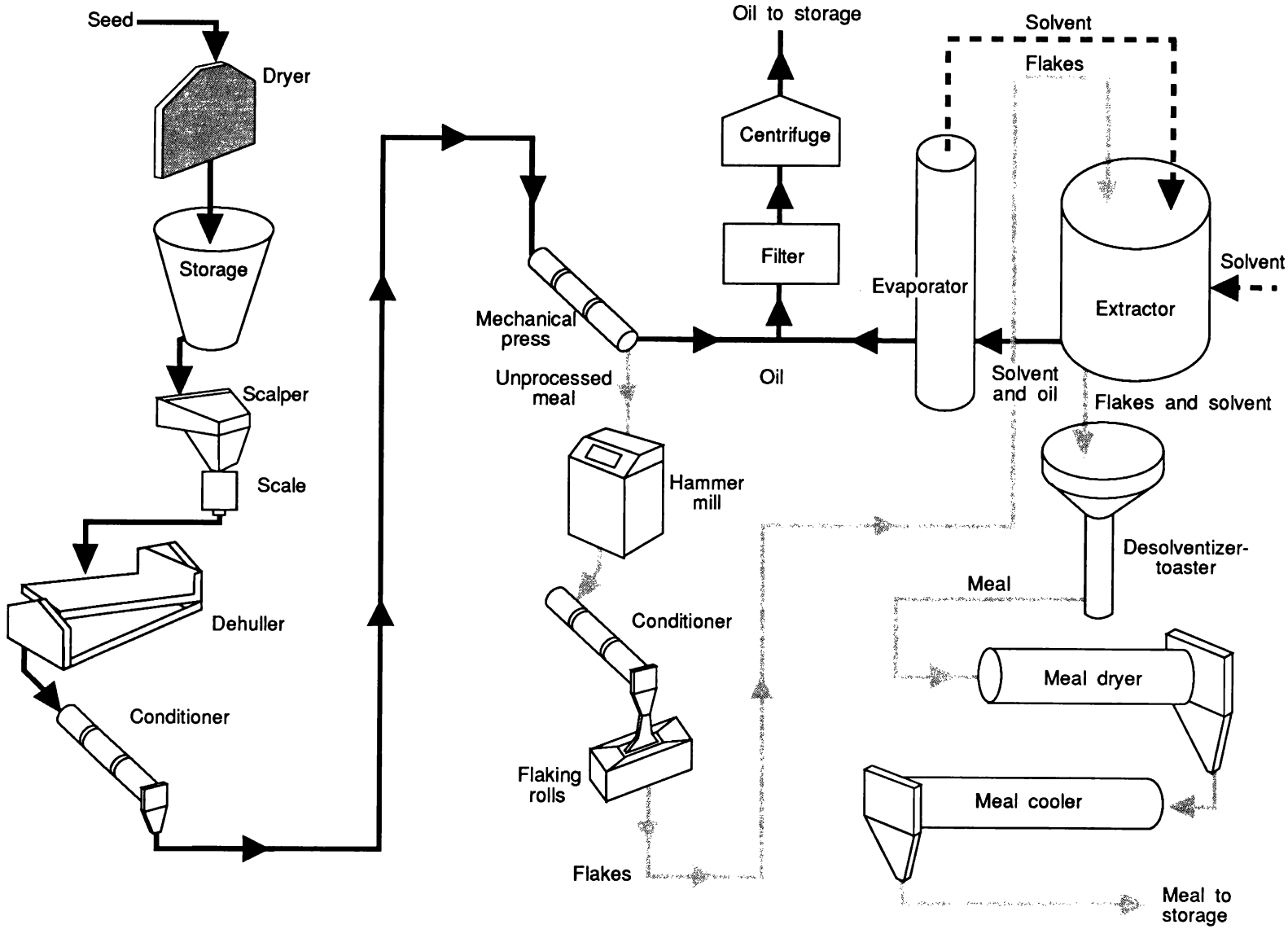
Building maintenance was assumed to be 2 percent of building costs per year; equipment maintenance was assumed to be 6 percent of equipment cost per year. Building maintenance is assumed to be a fixed cost because depreciation is usually more time-dependent than volume-dependent. Equipment maintenance costs are somewhat more variable with respect to output levels since use increases equipment wear and tear. In this analysis, both equipment and building maintenance are assumed fixed.

Both skilled and unskilled labor were assumed to be a variable cost, while department heads and the general manager were assumed to be a fixed cost. Labor costs are not variable in the short run, but operating at lower volumes of output will likely lead to layoffs over a longer term. Overhead and fringe benefits were estimated at 50 percent of direct labor costs.

Sales and administration costs were calculated at 10 percent of capital and annual operating costs. Selling costs are closely related to volume, but administration costs included not only sales staff but office personnel. These costs are somewhat less variable than solvent or energy costs in the short run. However, continued operation of the plant at less than capacity would likely dictate some reduction in sales and administrative expense. This intermediate cost characteristic is captured by relating them to both annual capital costs (fixed) and to annual operating costs (variable). Costs for solvent, energy, and water are directly related to volume and change with volume of production.

Appendix figure 1

Flow chart of a prepress solvent sunflowerseed plant



Source: Delmer L. Helgeson and others. *The Economic Feasibility of Establishing Oil Sunflower Processing Plants in North Dakota.* Bulletin 503. Agricultural Experiment Station, North Dakota State University, Apr. 1977.

Appendix table 2--U.S. sunflowerseed: Supply, disappearance, and price, 1977-91

Year beginning Sept. 1	Supply: Beginning stocks	Supply: Production	Supply: Imports	Supply: Total	Disappearance: Crush	Disappearance: Non-oil-use + seed	Disappearance: Exports	Disappearance: Total	Disappearance: Ending stocks	Price: Average received by farmers
	1,000 metric tons									*$/mt*[1]
1977	23	1,330	3	1,356	219	118	942	1,279	77	224
1978	77	1,823	7	1,907	292	159	1,366	1,817	90	236
1979	90	3,310	10	3,410	547	147	1,820	2,514	896	200
1980	896	1,697	28	2,621	780	154	1,505	2,439	182	245
1981	182	2,035	32	2,249	374	177	1,555	2,106	143	238
1982	143	2,419	40	2,602	766	191	1,348	2,305	297	199
1983	297	1,451	31	1,779	590	113	1,044	1,747	32	287
1984	32	1,698	26	1,757	567	128	991	1,686	71	249
1985	71	1,430	26	1,527	674	276	365	1,315	212	175
1986	212	1,214	8	1,434	635	242	304	1,181	253	152
1987	253	1,183	10	1,446	900	79	270	1,249	197	184
1988	197	813	25	1,035	575	294	87	956	79	267
1989	79	798	20	897	546	230	96	872	25	234
1990	25	1,031	40	1,096	593	297	168	1,011	85	240
1991[2]	85	1,637	10	1,733	875	357	147	1,329	354	187

[1]mt = metric ton. [2]Preliminary.

Source: U.S. Department of Agriculture, Economic Research Service. *Oil Crops: Situation and Outlook Report*. OCS-34. July 1992, p. 31.

Appendix table 3--U.S. sunflowerseed oil: Supply, disappearance, and price, 1977-91

Year beginning October 1	Supply			Disappearance				Price
	Beginning stocks	Production	Total[1]	Domestic	Exports	Total	Ending stocks	Average, crude, Minneapolis
	1,000 metric tons							*$/mt*[2]
1977	N/A	86	86	49	34	83	3	N/A
1978	3	115	118	70	41	111	7	728
1979	7	224	231	72	86	158	73	575
1980	73	298	371	29	301	330	41	594
1981	41	137	178	63	103	166	12	550
1982	12	303	315	43	229	272	43	495
1983	43	204	247	53	188	241	6	741
1984	6	219	225	65	130	195	30	661
1985	30	265	295	65	205	270	25	421
1986	25	266	291	84	156	240	51	353
1987	51	377	430	40	319	359	71	520
1988	71	235	306	57	212	269	37	500
1989	37	215	254	78	159	238	17	538
1990	17	243	275	90	163	254	22	520
1991[3]	22	359	386	135	230	365	20	463

N/A = Not available.
[1]Total supply includes imports. [2]mt = metric ton. [3]Preliminary.
Source: U.S. Department of Agriculture, Economic Research Service. *Oil Crops: Situation and Outlook Report*. OCS-34. July 1992, p. 32.

Appendix table 4--U.S. sunflowerseed meal: Supply, disappearance, and price, 1977-91

Year beginning October 1	Supply: Beginning stocks	Supply: Production	Supply: Total[1]	Disappearance: Domestic	Disappearance: Exports	Disappearance: Total	Disappearance: Ending stocks	Price: Average, 28-percent protein
	1,000 metric tons							*$/mt*[2]
1977	N/A	131	131	127	N/A	127	4	N/A
1978	4	180	184	180	N/A	180	4	102
1979	4	359	363	359	N/A	359	4	106
1980	4	439	443	440	N/A	440	3	122
1981	3	201	204	200	N/A	200	4	117
1982	4	434	438	433	N/A	433	5	112
1983	5	265	270	240	25	265	5	123
1984	5	321	326	307	14	321	5	58
1985	5	357	362	313	44	357	5	76
1986	5	305	310	269	36	305	5	84
1987	5	426	431	381	46	427	4	109
1988	4	291	302	293	6	299	3	135
1989	3	264	280	272	3	275	5	111
1990	5	296	319	309	5	314	5	97
1991[3]	5	435	449	413	32	445	5	79

N/A = Not available.
[1]Total supply includes imports. [2]mt = metric ton. [3]Preliminary.
Source: U.S. Department of Agriculture, Economic Research Service. *Oil Crops: Situation and Outlook Report*. OCS-34. July 1992, p. 32.

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